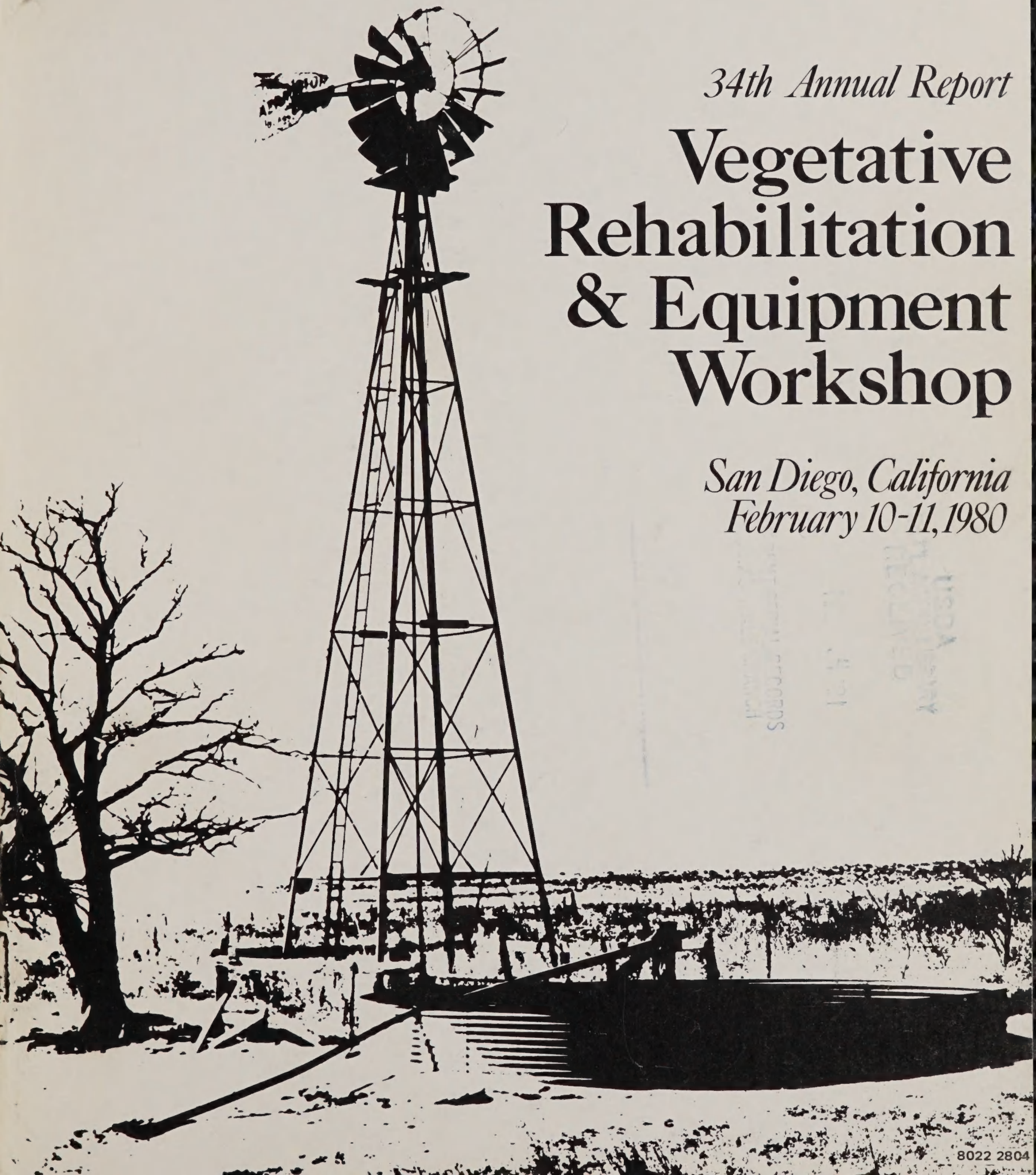

34th Annual Report

Vegetative Rehabilitation & Equipment Workshop

San Diego, California
February 10-11, 1980

The Vegetative Rehabilitation and Equipment Workshop is an organization of Federal and State agencies and private groups working to improve rangelands and further range equipment technology. Government officials and industry and university representatives from other countries also participate.

To accomplish its goals, the Workshop evaluates and develops equipment and prescribes specifications and standards for equipment purchase, maintenance, and use. The Workshop also functions as a clearinghouse for the interchange of information and the dissemination of material describing its activities and accomplishments.

Those interested in participating in the Workshop should contact its chairman, T. V. Russell, Range Management Staff, USDA Forest Service, P.O. Box 2417, Washington, D.C. 20013.

Cover: Stock watering tank and windmill on the Kiowa National Grassland near Clayton, N.Mex. Windmill is an 8-foot Aero Motor; tower is a 33-foot Dempster.

September 1980

34th Annual Report

San Diego, California
February 10-11, 1980

Participants

U.S. Department of Agriculture

U.S. Department of the Interior

State and County Organizations

State Wildlife Agencies

Industry Representatives (Chemical, Equipment, Mining, Seed)

Educational Institutions

Ranchers

Foreign Countries

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
WO

Dear Members and Friends of VREW:

Everyone I talked to was pleased with the turnout, program representations, and the general interest shown at our 34th annual meeting of the Vegetative Rehabilitation and Equipment Workshop (VREW) in San Diego.

We would like to thank the people from industry who attended, especially those making presentations. Your contribution is vital for VREW to accomplish its goals of improving rangelands and furthering rangeland equipment technology. We encourage those in attendance to bring a friend to our workshop in Tulsa, February 8-9, 1981.

Bill Leavell, our keynote speaker, challenged this workshop "to better inform all responsible persons and all agencies at all levels of what is available to do the work; and, further, to commit our resources to assuring that we have adopted the best of alternatives for having the right equipment, the right plant materials, and the right technology for doing that work for the specific efforts we are planning." To help meet this challenge, The Steering Committee placed more emphasis in FY 1980 on the activities of our Information Workgroup as evidenced by the publication of the *Revegetation Equipment Catalog*, approval and funding of a video tape program concerning range habitat improvement, and the article "VREW From the Start," which was published in the December 1979 issue of *Rangelands* magazine. The article is reproduced in this annual report. To further meet this challenge, the Steering Committee has asked each workgroup chairman to review the mission and membership of his workgroup and to suggest the needed changes at our Exploratory Meeting in Las Cruces, July 30, 1980.

If you would like to help meet "the challenge," contact either a VREW workgroup chairman on the subject matter of your choice or myself and make your desires known.

No workshop is a success without planning and work, by the local VREW members and local arrangements committee of SRM. Our 34th meeting was a success and I wish to thank the staffs of the Forest Service Equipment Development Centers, the workgroup chairmen, Dave Jones of the Angeles National Forest for arranging our visual equipment, and to Farnum Burbank, Engineering, WO, for doing the unpopular but "necessary" job of exercising a strong, but considerate hand in operating the Timing lights. Also, thanks to Barbara and Betty Laird and Sylvia McKenzie who were registering guests. Also, extra warm thanks need to go to Gail Sharp and Art Armbrust of Sharp Brothers Seed Company for waterhole arrangements.

This year we had three new workgroup chairmen who did an outstanding job as first year workgroup chairpersons. They were Ross Wight, Seeding and Planting Workgroup; Loren Brazell, Mechanical Plant Control Workgroup; and Ron Younger, Disturbed Land Reclamation Workgroup. It is through the efforts of the workgroup chairmen that VREW accomplishes its work. The location for our 35th annual Vegetative Rehabilitation and Equipment Workshop is Tulsa, Oklahoma. The workshop will be held in the Mayo Hotel at the corner of Fifth and Cheyenne, February 8-9, 1981. *Let me know now* if you need anything put on the program, as we will draft the agenda at Las Cruces.

For reservations write or call:

Mayo Hotel
115 West Fifth St.
P.O. Box 2101
Tulsa, Okla. 74101
(918) 583-2141
(FTS 736-7011)

I hope to see you all there.

Ted Russell

T. V. Russell, *Chairman*
Vegetative Rehabilitation
and Equipment Workshop

Contents

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VREW from the Start

John E. Larson[1]

The Vegetative Rehabilitation and Equipment Workshop is an informal group concerned with developing and testing revegetation equipment and providing information about suitable equipment to land managers. VREW has actually been around for quite a while and was formerly called the Range Seeding Equipment Committee. The group includes Federal and State agencies, universities, industry, professional organizations, and private citizens.

VREW meets each winter, usually just before the Society for Range Management meeting, to discuss activities and accomplishments, present new information, and recommend future action. The workshop is closely affiliated with USDA Forest Service Equipment Development Centers at Missoula, Mont. (MEDC), and San Dimas, Calif. (SDEDC), where much of the project work takes place.

VREW's roots go back to World War II, when more wool and beef were needed to sustain the war effort. With increased demand for sheep and cattle, increased productivity from National Forest rangelands was sought. However, many of these lands, already suffering from a long history of abuse, could not support additional livestock without substantial improvement. Large-scale seeding programs were implemented to accomplish the necessary improvement.

The programs proved successful, but it was soon discovered that available equipment, which was designed for crop production on farmland, was inadequate for rangeland. The rigors of rocky ground, steep slopes, and dense brush took their toll in broken implements. The poor performance of the equipment no doubt resulted in considerable frustration and some profuse swearing.

In 1945, Forest Service (USFS) administrators and researchers from western regions met to discuss the need for a major effort to test, adapt, or develop equipment suitable for range seeding. They invited the staff of the Forest Service Equipment Development Center, then at Portland, Oreg., to participate. A committee was formed to which Equipment Development Center personnel provided equipment and expertise to solve rangeland equipment problems. This committee became known as the Range Seeding Equipment Committee. In 1975 it was renamed the Vegetative Rehabilitation and Equipment Workshop (VREW), reflecting its expanded scope.

The committee met formally in December, 1946, in Portland, Oreg. Members drew up a charter in which they agreed to: consider, evaluate, and assign priorities to equipment problems suggested by the Forest Service Regions; prepare a program of work each year for the Portland Center; and provide specifications for the most desirable equipment for range seeding. In 1949, the committee expanded its objectives to function as a clearinghouse for information exchange and act in an advisory capacity in range seeding and undesirable plant control policies and procedures.

[1]The author is a range technician for the USDA Forest Service Equipment Development Center, Missoula, Mont.

About this time, several other agencies that were experiencing similar equipment problems became interested in the committee. The Bureau of Land Management (BLM) participated in the 1949 meeting and began to contribute funds in 1951. The Soil Conservation Service (SCS) and the Bureau of Indian Affairs (BIA) began attending meetings in 1949 and 1952, respectively, and funded projects beginning in 1955. In 1955, the committee voted to retain its informal structure to foster broad participation and a free exchange of information. Today, a list of participating Federal agencies would resemble a bowl of alphabet soup, including most of the agencies involved with natural resource management.

Participation with State agencies, universities, manufacturers, energy companies, seed suppliers, ranchers, and consultants is actively sought. These people often support VREW by providing equipment and materials for testing and by contributing with field operations and evaluation, in addition to VREW workgroup memberships.

VREW projects generally involve either evaluation of commerically available equipment adapted for wildland use or development of new equipment to satisfy special needs. Projects are approved and funded according to priorities determined by the contributing agencies. Project proposals come from a variety of sources, including surveys of field personnel, spinoffs from previous development work, or suggestions from researchers, ranchers, and other interested individuals. The proposals are submitted each year to the VREW exploratory committee, which determines their feasibility. Promising proposals are then forwarded to the two USFS Equipment Development Centers for cost estimates. Finally, they are referred to the VREW steering committee for approval and funding.

Projects are assigned to various workgroups within VREW. The workgroups supervise or perform most of the project work. They meet periodically to review the progress of their projects, plan for future projects, and exchange information. In addition, each VREW workgroup summarizes its activity in a report at the annual meeting. These reports are published each year and are sent to the membership. They are available on request.

Over the years, VREW has been responsible for developing many types of rangeland equipment. Some of this equipment is now manufactured commercially and widely used. The best example of this is the rangeland drill. The project was initiated in 1951 to develop a grain drill capable of sustained operation on rangelands. The prototype was developed from a modified commercial grain drill constructed for the Fremont National Forest in Oregon. It featured heavy-duty, single-disk openers and independently suspended disk arms that could ride up and over any obstruction. The prototype was completed in 1952 and has remained basically unchanged, although modifications and refinements such as deep-furrowing disk arms, optional grain and fertilizer boxes, depth-control bands, and brush guards have increased its efficiency and versatility.

Rangeland drills are currently used throughout the Western United States and in several foreign countries for range improvement and disturbed land reclamation. The project was terminated in 1974 following publication of the service and parts manual by SDEDC and the operations handbook for the rangeland drill by the BLM. However, commercial manufacture and development still continues.

Current VREW projects cover a broad spectrum, from the development of a portable vacuum seed collector for harvesting brush and grass seed, to the evaluation of aerial ignition techniques for use in wildlands. Emphasis is now being placed on developing equipment for reclaiming strip-mined land and revegetating disturbed areas in arid climates. The difficulty of establishing permanent, diverse vegetative cover on these areas is a continuing concern to land managers.

The modified Hodder gouger is one of several projects dealing with this problem. This project was initiated by the BLM Energy Mineral Rehabilitation Inventory and Analysis Program (EMRIA). It involved testing and improving a gouger developed at Montana State University (MSU).

Gouging, or pitting, creates a series of depressions in the soil that collect moisture and provide shelter for plant establishment. The problem was to create enough depressions of sufficient size and with adequate spacing for effective revegetation of large areas. A cooperative effort by the MSU staff and MEDC engineers produced the modified Hodder gouger, featuring automatic blade action, adjustable blade configurations, and hydraulic depth control. These features allow the depressions to be formed in a variety of sizes and patterns.

The modified Hodder gouger is also equipped with a seed box capable of metering many kinds of seed at varying rates. The gouger was tested in 1977 at the Western Energy Company mine at Colstrip, Mont. It proved capable of producing many large depressions while seeding a variety of species at the prescribed rate. The modified Hodder gouger is now being operated by the BLM and continues to provide efficient treatment of disturbed lands.

Besides developing and testing equipment, VREW provides information about techniques and equipment for revegetation. This information is contained mostly in various Equip Tips, Project Records, and other reports produced by the Equipment Development Centers. Examples of VREW publications include the VREW annual reports, operations handbooks, service and parts manuals, and equipment handbooks. Perhaps the best known among these is the *Range Seeding Equipment Handbook*, which has recently been updated as the Revegetation Equipment Catalog. This catalog describes a broad range of revegetation equipment, from plant control and seeding to seed collection and transport. It also outlines techniques for using the equipment, discusses equipment capabilities and limitations, and lists manufacturers or sources of information.

There is a trend in VREW to provide more information useful to land managers and to gather and distribute such information more actively. Several handbooks are forthcoming concerning other aspects of land rehabilitation. These publications should prove valuable to land managers when planting and implementing land treatments.

Until complete rehabilitation of disturbed lands has been demonstrated, or progress in equipment technology comes to a halt, the need for new ideas, better equipment, and up-to-date information will persist. So, if you're out on a project and your equipment breaks down and you think, "There must be a better way," look into VREW. Chances are, there is a better way. VREW is dedicated to solving equipment problems and has the expertise available to deal with most land rehabilitation situations. For more information concerning VREW, contact the workshop chairman, *Ted Russell, Forest Service Range Management Staff, P.O. Box 2417, Washington, D.C. 20013*, or come to the Society for Range Management winter meeting a few days early and attend the workshop. You will learn of the latest equipment developments for land rehabilitation.

Agenda

Sunday—Feb. 10

9:00 am **Welcome** . . . . Ted Russell, *Chairman*, VREW
Forest Service, Wash., D.C.

Introductory Remarks . . . . Bill Leavell
Associate State Director
Bureau of Land Management
Utah State Office

Morning Discussion Leader . . . . Arlo Dalrymple
Office of Surface Mining
U.S. Department of the Interior
Wash., D.C.

Workgroup Reports

Information . . . . .Dan W. McKenzie
Forest Service, San Dimas, Calif.

Seeding and Planting . . . . Ross Wight
SEA-AR, Boise, Idaho

Arid Land Seeding. . . . . .Carlton Herbel
SEA-AR, Las Cruces, N.Mex.

Plant Materials . . . . Gil Lovell
SCS, Wash., D.C.

Disturbed Land Reclamation . . . . .Ron Younger
BLM, Salt Lake City, Utah

Special Report —American Council for Reclamation
Research . . . . Arlo Dalrymple
OSM, Wash., D.C.

12:00 noon **Lunch**

1:00 pm **Afternoon Discussion Leader** . . . . .Dan Renteria
Bureau of Indian Affairs
Wash., D.C.

Workgroup Reports

Seed Harvesting. .A. Perry Plummer
Forest Service (ret.) Provo, Utah

Steep Slope Stabilization . . . . .Lou Spink
Forest Service, Baker, Oreg.

Thermal Plant Control . . . . Bill Davis
Forest Service, Ogden, Utah

Mechanical Plant Control . . . . .Loren Brazell
BLM, Reno, Nevada

Chemical Plant Control. . . . . Dick Hallman
Forest Service, Missoula, Mont.

Structural Range Improvements . . . . Bob Hamner
Forest Service, Dickinson, N.Dak.

Papers and Special Reports

Canadian Land Reclamation Association
Report on Annual Meeting . . . . Farnum Burbank
Forest Service, Wash., D.C.

Dryland Sodding—A Summary . . . . Jane Bunin
Science Application, Inc., Boulder, Colo.

New Prescribed Burning/Backfiring Tool
Tested in Brush . . . . Denny Bungarz
Forest Service, Willows, Calif.

Monday—Feb. 11

8:00 am **Discussion Leader** . . . . .Kent Crofts
Energy Fuels Corp.
Steamboat Springs, Colo.

Papers and Special Reports

Rare Plant Propagation. . . . . .Phillip Dittberner
Fish and Wildlife Service, Fort Collins, Colo.

What's New in Seeds . . . . Art Armbrust
Sharp Brothers Seed Co., Healy, Kans.

New Forage Plants for Rangeland . . . . Douglas Dewey
SEA, Logan, Utah

GAUCHO® Barbed Wire. . . . . .Jan A. Smolders
Bekaert Steel Wire Corp., Niles, Ill.

A Wood Densifier . . . . .Walt Turner
Calif. Dept. of Forestry, Riverside, Calif.

Using Solar Energy in Developing
Range Watering Systems . . . . Chuck McGlothlin
Forest Service, Billings, Mont.
Roy Lockhart
Bureau of Indian Affairs (ret.)

Chaparral Vegetation Management
Alternatives . . . . J. L. Hickman
Forest Service, Riverside, Calif.

Mine Reclamation Costs and Systems . . . . . . Michael J. Cwik
Intermountain Resources, Ltd., Spokane, Wash.

Forest Service Equipment Development Center Activities
San Dimas, Calif.. . . . . .Dan W. McKenzie
Missoula, Mont.. . . . . Dick Hallman

Wrap-Up . . . . Ted Russell, *Chairman*, VREW
Forest Service, Wash., D.C.

12:00 noon **Meeting Adjourned**

Rangeland Improvement — A Challenge for Us in the 1980's

William G. Leavell, *Associate State Director,*
Bureau of Land Management, Utah State Office

Thank you for inviting me to the 1980 Vegetative Rehabilitation and Equipment Workshop. San Diego is a good location to hold such a winter work session. This weather is certainly appreciated by some of us who live and work a little farther north.

When asked if I would present some introductory remarks and a challenge for the future, I looked forward to this moment with both anticipation and concern; concern that, never having been an attendee at one of the sessions, I'd be breaking new ground in my comments, possibly from a naive, uninformed perspective; anticipation because, as a manager, I have been doing quite a little thinking recently about the 1980's, where we have been, where we are, and where we ought to be at the end of this decade in regard to rangeland management. I'll try to emphasize some of my concerns and expectations in the next few minutes. My perspective is particularly oriented from the view of a Bureau of Land Management employee—a line manager. Perhaps other agencies, other managers, will have different views—but these are mine.

Ted Russell asked that I build my discussion on any of three general areas: (a) the equipment needed to carry out the Federal Land Policy and Management Act and the Public Rangeland Improvement Act; (b) equipment needed to rehabilitate surface-mined disturbance; or (c) ways and means for technology transfer.

The initial urge to talk about equipment needs was great. But after reviewing the reports of the last 2 years I came to the realization that much has happened in the last 20 years to bring equipment sophistication to us. Far be it for me to say what is needed in today's world. I had been thinking in terms of equipment of 20 years past: the brushland plow, the anchor chain, the rangeland drills, etc. In the meantime, you have passed me by with such machinery as low-energy grubbers, land imprinters, steep-slope seeders, basin blades, and shrub spriggers. New plant materials have emerged and new techniques—such as thermal brush control. For all I know, there may be enough equipment varieties and innovations in place, on the drawing board, or in your minds to do most anything we need to do in the eighties.

I was also drawn to the desire to talk about equipment for surface-mined disturbance. I've had some specific responsibilities in coal management matters during the last several years. And I am particularly concerned about the results of a probable great acceleration in the coal energy program, especially in surface minable areas.

But I believe that in the eighties we must place our greatest emphasis on improving all rangelands to meet all needs. So I came to the conclusion that the time is right to issue the real challenge to this group and to all rangeland managers and users—that is, to assure that the information and results of your many years of research, development, and thinking be put to work, on the ground.

It is on this topic then—technology transfer—that I want to put the emphasis of these introductory remarks.

Let's set the stage a little. Like many of you, I entered into a land management career, fresh out of school. Just off the ranch, so to speak. Responsibility in the 1950's, was generously given out to all of us newcomers in the BLM District Offices. Quite often, the addition of two or three of us to a District staff often doubled that staff. We were immediately given impressive titles like "Range Conservationist" or "Range Manager" and put in charge of such project programs as soil and moisture, halogeton control, or range improvement.

In the early fifties our projects consisted of stock pond construction, spring development, fencing, and a newly emerging program of land treatment through sagebrush plowing, crested wheat grass seeding, aerial spraying, and some pinyon-juniper chaining, at least in the region I was located in. Over in Region 3, the Bureau's Northern Great Plains Area, large detention reservoirs, water spreaders, contour furrowing, etc., were major project types.

We learned our job the hard way in on-the-job training with an old, experienced hand, by trial and error. And many of our errors are still with us in the broken dikes, unsuccessful seedings, and abandoned equipment. On the other hand, we did have our successes, and we did improve in our way of doing business. People like Don Hyder, Forrest Sneva, Art Sawyer, Neil Frischknecht, and many others gave us the research and practical tips for a better way of doing that business. For example, I still remember that spraying for sagebrush in eastern Oregon should be done when June grass is in the "boot" to get the best results.

We learned to innovate just like on the farm—using bailing wire and whatever scrap iron was around—to get the job done using what was available, whether it be surplus equipment or a patched up piece of farm machinery used in a different way.

Many of you in the room continued in the research, development, and application end of the business of range improvement. But, for many of the rest of us, it was on to other things, and eventually a desk-bound job where we were still involved in range

improvement but at a different level and perhaps in a way that bears out the saying, "A little knowledge can be dangerous." The point I want to make is that many of us remember range improvement and land treatment as it *was* done rather than as it is or can be done now.

We know the history of the range improvement funding levels—oriented almost exclusively to improving soil, vegetation, and livestock grazing conditions and how the funding rose and fell with the times. The large acreages of vegetative conversion dramatically dropped in numbers toward the end of the sixties. The seventies brought better planning for many uses with the accompanying environmental requirements.

The experienced project work force of the fifties and sixties dwindled. The faces have changed at the field level in those jobs that carried out the range improvement program on the ground. We find today that only 24 percent of BLM's present employees were with us in 1965 and only 22 percent of our range conservationists go back more than 10 years.

With this very general background, primarily on BLM operations—but perhaps the shoe may fit your individual agencies also—let's consider these facts:

- We know our present rangeland conditions require carefully planned and managed improvement action using the best available ways and means. As mentioned last year in Reg DeNio's talk: "Fifty-four percent of the rangelands in the 'lower 48' States—some 350 million acres of private, State, and Federal rangelands—[are] in poor or in very poor condition, with vegetation and soil conditions estimated to be at or less than 40 percent of their potential."

- We know the Congress recognized this problem and gave its authorization for a greatly accelerated program of range improvements under the Public Rangeland Improvement Act—$365 million over the next 20 years. This could triple the amount of funding BLM alone receives for range improvements annually. We have now completed 22 environmental statements of the 144 covered by the Natural Resource Defense Council suit, thus opening up the possibilities of a great acceleration in range improvement.

- We are not ready at this point to accomplish all that we are expected to accomplish with the funding to be made available. Nor do we now have the experience to undertake the effort before us. I am convinced that many managers in the position to allocate funding for rangeland improvement through better or more equipment, better technology, or better plant materials are just not up

to date as to what options are available to them. I made an informal survey of many of our field managers and we came to the conclusion that, as managers, we are not up on the state-of-the-art in range improvement. We do not know of any coordinated effort to assess the problem, propose solutions, evaluate the economics, and reach an informed decision on where to go from here.

- Further—and this may be far more serious—there is quite likely a great lack of experienced people in our field offices who are trained and ready and able to carry out an accelerated program of range improvement practices throughout the West. For every example where we are making some very concerted and successful efforts, there is an example of concern by managers that they are just not ready to move out on a large, cost-effective rangeland improvement program.

This adds up to a serious shortage of overall capability and knowledge to carry out a program that is *expected* by those who can commit us to high goals of rangeland improvement. I certainly don't want to be embarrassed by my inability to produce. But, as a manager, I well could be. I now know that I am not alone in that concern.

I agree wholeheartedly with the comments made in 1979 by the Information Work Group chairman:

> Effective dissemination of information is a challenge that any group or organization engaged in development work faces. Information transfer, however, is an activity often put aside because the work is routine and not appealing to most people engaged in development work . . . . This is especially true in resource management, where field units are widely scattered and personnel usually work independently. It is difficult for many land managers to stay abreast of the best tools and techniques available.

Now, what can be done? First, I think the time is right for solutions. We've talked about the need to accelerate rangeland improvement efforts for years. I suspect our hand has been called and we've got to produce. With some thinking on the matter, I believe that managers and specialists alike will become concerned and want to place themselves in a better position of being able to produce. So I think we are going to have a receptive audience to any good program and its alternatives; a program which explains our economic, environmental, and technical options, and ways and means of getting the job done with the right equipment, materials, and techniques.

Second, I believe any effort undertaken must involve the entire rangeland community, from the most intensive user (perhaps the mining industry) to the least knowledgeable of our general public; from the most ardent environmentalist to the most concerned range livestock operator; from the university professor to the economist. All must be involved, whether they are a payee as a taxpayer or a receiver as a consumer of the product.

We must realize that all levels of government are by necessity involved in all land matters affecting their area of responsibility. We must be sure that we fully involve them, not only in the decisions on land improvement, but also in helping to finance and carry out that effort in the most cost-effective manner. The use of advisory groups, such as the Experimental Stewardship Program, and the involvement of people through workshops and symposiums seem to offer a forum for arriving at solutions to the problems and proposals developed by this group. In other words, let's be sure we don't miss anyone, involve everyone, and in a way that works toward the solution.

Third, let's zero in on possibilities with the best payoff in terms of progress and proper land management. I suspect plenty has been done with certain equipment development, plant material, research, and technology application. Let's get our audience informed to use what we have rather than explore to infinity. I hasten to add this is not a call for stopping research and development on equipment, etc. But we perhaps ought to channel our efforts into technology transfer priorities for those changing or adaptive methods which must follow as a result of the changing use patterns on rangelands; for example, prefabrication of facilities for development within wilderness study areas to reduce onsite construction impacts. And, let's stay in key with national concerns of energy conservation and efficiency.

Fourth, let's concentrate on information techniques. In other words, let's really communicate effectively to all audiences, whether they be managers, users, or specialists. For example, publications have been a prominent method for getting information before others. But we are competing for the time of the right people, and by right I mean those involved in planning, in management, and in implementation, to both understand what is available and to best utilize whatever is available. Let's try more work demonstrations, perhaps at centralized locations. Let's invite planner, manager, and specialist to participate. For those who can't attend, let's consider the use of videotapes and concentrate on getting exposure, interest, and knowledge to the management and specialty teams.

Fifth, let's think about improving organization and management techniques to facilitate technology transfer and utilization; for example, central equipment control centers. Let's concentrate on options for acquiring equipment, not only through purchase, but also through unique leasing arrangements. Perhaps we should consider various techniques of contracting where the agencies would provide specialized equipment and contractors would operate the equipment. These are really not new ideas but rather the process of making us think out our possible options which is the most important, perhaps, at this point. Let's not forget specialized equipment scheduling and interagency trading. Of course, the bottom line is to get the best equipment options, the best technological processes, and the best plant material options before the planners, the managers, and the implementation team.

If the time is right, if the eighties will be a decade of great improvement effort, we must pay the bill. So perhaps the need to transfer information and for further research and development must be quantified in terms of the funding required to make such a program successful. If there is a need, there will be a willingness to pay for the solution. If managers feel the need, they can motivate their organizations to assure that the priority is given to reach the solutions.

In summary, the forecast is for a great acceleration of rangeland improvement for all resource purposes during the decade of the eighties. The lull before the storm has been with us for some years. We are in a position of finding ourselves, as managers, in the position of needing all the technology and equipment options we can get to capitalize on the opportunities before us. We are faced with a need to better inform all responsible persons and all agencies at all levels of what is available to do the work. Further, we must commit our resources to assuring that we have adopted the best alternatives for having the right equipment, the right plant materials, and the right technology for doing that work for the specific efforts we are planning. To make all this come together in a cohesive, coordinated way is a tremendous undertaking for this group. That is our challenge!

Workgroup Reports

Information

Ray Dalen, *Chairman*

(Reported by Dan McKenzie)

Accomplishments

- The *Revegetation Equipment Catalog* was published in March 1980, and distribution to Federal agencies is in progress. Copies are also available through the Superintendent of Documents for $6. To order a copy, write: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; ask for Stock No. 001-001-00518-5.

- The VREW's 33rd annual report was prepared, and 1,100 copies were distributed to interested individuals and organizations.

- An article was prepared and published in *Rangelands* magazine reviewing the history and accomplishments of the Workshop. The article was published in the December 1979 issue.

- An American Society of Agricultural Engineers paper, describing some of the activities of the VREW, was presented at the winter meeting of ASAE in New Orleans, La., December 1979. The paper, "Agricultural Engineers Role in the Rangeland Improvement and Rehabilitation Equipment," was by Farnum M. Burbank, chief equipment development engineer, Forest Service, Washington, D.C. The paper number is 79-1610.

- The agenda for the 34th VREW annual meeting in San Diego was prepared and distributed 45 days before the meeting to give people ample time to make plans to attend.

- A guidance group for Project 0411, Range Habitat Improvement Slide/Tape, met at the Equipment Development Center in Missoula, Mont., Dec. 12 and 13, 1979. The group decided on a video tape emphasizing equipment. The program was tentatively divided into four sections. The first would briefly describe good range practices and principles; the second would cover mechanical brush control equipment; the third, ground preparation equipment; and the fourth, seeding equipment.

- The VREW history booklet has been updated, reviewed, and will be going to press in a few months. One interesting new item included is an organizational chart showing some of the lines of communication among organizations involved in VREW.

- The Chemical Plant Control Workgroup has completed a draft of a handbook on the aerial application of herbicides. Copies are being circulated for review and comment.

Planned

- Develop plans for accomplishing Project 0411. Initial work will focus on three areas: searching for existing footage of equipment; developing a shooting script; and arranging locations where equipment can be taped in field settings.

- Publish VREW history booklet.

- Distribute copies of the *Revegetation Equipment Catalog* to Federal agencies and inform other individuals and organizations about the availability of this publication from the Superintendent of Documents.

- Prepare and publish the VREW 34th annual report and distribute it.

- Prepare and distribute 45 days before the 35th annual meeting, the agenda planned for Tulsa, Okla., February 8 and 9, 1981.

- Publish handbook on aerial application of herbicides.

Proposed

- Update slide presentation of VREW activities.

- Put an article about VREW in *Reclamation Review* magazine.

Arid Land Seeding

Carlton H. Herbel, *Chairman*

Arid Land Seeder

By Carlton H. Herbel, Science and Education Administration—Agricultural Research, Jornada Experimental Range, Las Cruces, N. Mex.

The arid land seeder project aims to develop equipment that will create the microclimate needed for successful seeding of arid land. The Science and Education Administration—Agricultural Research at the Jornada Experimental Range near Las Cruces has demonstrated that more favorable temperature and moisture conditions exist for germination and seedling establishment when uprooted vegetation is placed over seeded rangeland. This method also helps protect seedlings from emergencies such as drought. The plowed brush creates a microclimate that lowers the maximum daytime soil temperatures and increases the soil water.

Reductions in maximum soil temperatures during the critical summer period averaged 28° F at the ½-inch depth. During an 80-day period in summer, soil water was available at the ½-inch depth for 29 days under brush cover. This compared to only 9 days where no cover existed on the soil surface.

Using this information the Agricultural Engineering Department at New Mexico State University, in cooperation with SEA-AR, designed and built the arid land seeder. It was originally pulled by a crawler tractor equipped with a rootplow. The equipment picks up the plowed brush from the ground, forms basin pits, firms the soil, plants seed, and then deposits the brush on the seedbed as cover.

In 1979, the arid land seeder was separated from the crawler tractor equipped with the rootplow. The rootplowing was then done separately followed by the arid land seeder pulled by a large four-wheel-drive tractor. This arrangement, rootplowing and seeding separately, worked much better and was much faster than when the crawler tractor equipped with a rootplow pulled the seeder, and rootplowing and seeding was done in one operation. This technique was used to treat 75 acres infested with creosotebush in 1979. Lehmann and Boer lovegrass, black and sideoats grama, yellow bluestem, blue panicgrass, and fourwing saltbush were seeded.

Over 200 acres on the Jornada Experimental Range have been treated with this equipment between 1976 and 1979. Another area will be treated with the herbicide tebuthiuron. A third area was left untreated as a control plot. The effectiveness of the mechanical and chemical treatments on the range ecosystem will be studied and compared with the untreated area.

Rangeland Imprinter

By Robert M. Dixon, Science and Education Administration—Agricultural Research, Southwest Rangeland Watershed Research Center, Tucson, Ariz.

The rangeland imprinter creates surface conditions that concentrate, infiltrate, and conserve rainwater. This makes more moisture available for seed germination, seedling establishment, and forage production in semiarid and arid regions. Rainwater is concentrated in seedbeds and seedling cradles by gravity flow from a series of water shedding furrows. Seedbeds and seedling cradles, a series of cross-slope furrows connecting with the shedding furrows, absorb water. The result of both the rainwater-accumulation and plant-mulching functions of the rangeland imprinter is conservation of absorbed rainwater. The accumulated rainwater further penetrates the soil and less moisture evaporates.

Rangeland imprinter operating on a creosotebush-infested area near Tombstone, Ariz.

Increased absorption also conserves rainwater by reducing runoff and by increasing the depth of water penetration per unit of rainfall. Compared with a bare surface, water infiltrates deeper and idly beneath mulch because soil macropores function better as major fluid flow routes.

In 1979 field studies were conducted to determine how well the land imprinter satisfies its design criteria. These studies involved measurements of: (1) infiltration in the water shedding and water absorbing imprints using a Bertrand-Parr infiltrometer; (2) soil imprintability (and compaction), using cone-tipped penetrometers; (3) biomass vertical distribution, using a specially developed sampling frame; and (4) aboveground biomass production, using the gravimetric (clipping, drying, and weighing) method. Results show that the imprinter functions as designed, concentrating and conserving rainwater for increased biomass production.

Generally biomass production has been difficult to evaluate because of substantial but unknown levels of consumption by herbivores. The relatively small areas that have been imprinter-seeded become oases to hungry cattle and wildlife. This situation has been aggravated by the drier-than-normal growing seasons since the testing began in 1976.

However, land imprinting has shown good potential. At the Fort Huachuca, Ariz., trial, 500 acres of bulldozer-cleared land was imprinter-seeded to weeping and Lehmann lovegrass in July 1978. Ten months after seeding, biomass had accumulated to 2,853 pounds for imprinted and 50 pounds for unimprinted land. After 18 months the totals were 4,144 pounds for imprinted and 291 pounds for unimprinted lands. Grass seeds broadcast onto the unimprinted land failed to germinate; consequently, the low production from this land consisted primarily of relatively unpalatable weeds such as Russian thistle.

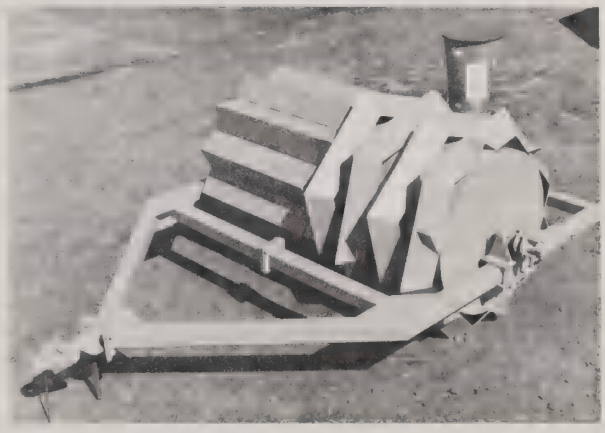
Manufacture of Rangeland Imprinter

By John Laird, Laird Welding & Manufacturing Works, Merced, Calif.

Laird Welding & Manufacturing Works now manufactures, under a U.S. Government license, two sizes of the rangeland imprinter. One is a metric size unit with 1-meter-diameter by 1-meter-wide capsules. The other is an English size unit with 46-inch-diameter by 48-inch-wide capsules. The reason for manufacturing this larger unit is to eliminate materials waste from the standard-size steel plates. This also has the advantage of extra weight and thus deeper soil imprints. The frame of the larger unit is made of square tubing and can be disassembled for shipping. The unit is also equipped with a heavy-duty swivel hitch that gives greater flexibility on rough terrain.

Laird Rangeland Imprinters

Imprinter size	*Treatment width (in)*	*Weight (lb)*	*Weight with water (lb)*	*Cost fob Merced (Mar '80)*
Metric unit	79	5,300	8,400	$ 8,250
English unit	96	7,700	13,200	$11,135



English size rangeland imprinter with 46-inch-diameter by 48-inch-wide capsules and square tubing frame that can be disassembled for shipping.

Heavy-duty swivel hitch provides flexibility when pulling over rough terrain.

Seeding and Planting

Ross Wight, *Chairman*

Workgroup Activities

- Some changes were made in the Seeding and Planting Workgroup membership, including a new chairman.

- A paper entitled "Automatic Bandoleer Feeder for Transplanters" by Walter L. Moden, Jr., and Harold L. Brewer, was presented at the winter meeting of the American Society of Agricultural Engineers, New Orleans, La., December 11-14, 1979. Work is continuing at Temple, Tex., and Moscow, Idaho, on the automatic feeding systems.

- A Tye rangeland seeder mounted in front of a rangeland imprinter was used to seed 2,000 acres of root-plowed brushland in southwest Texas.

- Utah Division of Wildlife Resources continued work with the rangeland interseeder and tree and shrub transplanter.

- John Laird reported some modification on the rangeland drill.

- Stephen Monsen reported on the adaptation of the Hansen seeder and Sieco fireplow to a rangeland interseeder.

A Rangeland Renovation Project in Southwest Texas

By John Tye, The Tye Co., Lockney, Tex.

This presentation outlines activity to renovate rangeland on a ranch in southwest Texas during 1979.

The Beef Canyon Ranch, near the Big Bend National Park, is composed of about 21,000 acres of semiarid rangeland. The land is infested with greasewood brush, mesquite trees, and very sparce stands of native grasses interspersed with rock. Grazing capacity in its unimproved state was approximately 200 head of cattle on the entire ranch.

The new ranch owners had done some small-scale rangeland renovation in prior years, principally involving rootplowing, plowing, and aerial seeding of native grasses. The results had been somewhat eratic.

Many problems were encountered with the aerial seeding. For example, a uniform seeding rate for the various seeds in seed mix could not be maintained. A proper covering of the seed and good seed soil contact was not achieved.

In 1979, the owners elected to attempt an integrated plan of rangeland renovation on a larger scale. Assisted by the county extension agent and a representative of the Soil Conservation Service, the owners selected 2,000 acres of the best flat bottom land for renovation. These acreages were rootplowed. Larger pieces of brush and trees were bulldozed into piles on the edge of the plot and the land plowed with a large offset disk.

These processes left the land very loose and powdery, but still littered with small piles of brush, large limbs, tree trunks and branches, as well as rocks, outcroppings, and other piles of debris. To obtain the required seed metering and placement systems, seeding was accomplished using a Tye Rangeland Seeder mounted in front of a land imprinter. The Tye seeder is a "Wiedemann type," using one seed hopper for light, chaffy seeds with a picker wheel type seeder; a separate smaller hopper uses externally fluted seeders for small, dense seed. The seed is dispensed through rigid seed tubes hinged to the main frame. This allows the tubes to ride up and over obstructions while still delivering seed uniformly to a groove formed in the soil surface.

This particular seeder arrangement was pioneered by Harold T. Wiedemann at the Texas Agricultural Experiment Station in Vernon, Tex. The land imprinter is based on a design developed by Robert M. Dixon of the Science and Education Administration, Tucson, Ariz.

Seeding took place during the first half of April 1979. The seed mixture consisted of the following amounts of pure live seed per acre: 2 pounds Johnson grass, 1 pound sideoats gramma, ½ pound plains bristle grass, 1/10 pound fourwing saltbush in one hopper and 6/10 pound blue panicum and ½ pound Lehmann lovegrass.

The first half of 1979 was an exceptionally dry year with virtually no rain through June. Normal rainfall for the area is about 9 inches per year. During 1979 less than 7 inches was recorded. The planted grass came up to a stand, but there was not enough moisture to keep the stand growing. In mid-August about 2½ inches of rain fell, which allowed the grass to come back and continue normal growth. After the September through November rain season, the carrying capacity of the 2,000-acre renovated rangeland increased to around 350 head.

The lack of rainfall resulted in practically no growth of grass on other portions of the ranch and necessitated heavy overgrazing of the renovated area with cattle on hand during late 1979. This severe overgrazing, combined with the detrimental action of the cattle hooves on the soft, renovated fields set back growth of grass on the renovated area. Examination shows that the root systems still remain intact and that adequate

rain and a rest from grazing should bring the grass stand back.

The success of this seeding practice depends mainly on adequate rainfall. Without it, stand establishment and growth of the native and introduced grasses is severely retarded. On the other hand, large amounts of rainfall in a short period seal over the light, powdery soil, causing later rains to run off rather than be absorbed into the soil profile. The land imprinter minimizes these problems after seeding. But more crust fracture and small reservoir establishment appears necessary.

Further work is planned in 1980 in cooperation with government and university personnel. Work will include more seeding and use of different types of spiked rollers to break the crust and create small reservoirs for containing rain water.

Benefits gained thus far in the renovation program point to these procedures as being economically viable practices for rangeland renovation in the arid and semiarid Southwest.

Successful Interseeding of Shrubs and Forbs into Perennial Grass Communities

By Richard Stevens, Utah Division of Wildlife Resources, Ephraim, Utah

Funds for this work were provided by Federal Aid in Wildlife Restoration through Project W-82-R.

The Forest Service San Dimas Equipment Development Center (SDEDC) was assigned a project to develop a demonstration interseeder that could operate on rangelands. A five-component interseeder was developed, tested, and modified in Utah and southern Idaho over the past 3 years.

A John Deere, model 350, diesel, crawler tractor rated at 42 drawbar horsepower was the prime mover. SDEDC designed and constructed an implement-carrying hitch that was mounted on the tractor at its real-hitch point. By using the real-hitch point, the implement remains in the ground with varying soil conditions and as the tractor turns and moves up and down on uneven ground. Originally, the interseeder was equipped with a single-disk trencher.

Wiedemann rangeland seeder and Dixon rangeland imprinter combined to make the Tye Co. experimental rangeland seeder. Seeder is being used to renovate lands on the Beef Canyon Ranch in southwest Texas.

Because of unacceptable results, a modified Hansen scalper, double-disk trencher and Sieco fireplow were evaluated for their effectiveness in making an acceptable scalp.

To accomplish effective interseeding into existing vegetation, scalps need to be made that are: (1) deep enough to remove all seeds, crowns and rhizomes of existing vegetation; (2) wide enough to allow seeded species to become established before reinvasion or competition occurs from surrounding vegetation; and (3) of such a shape and size that they are effective water harvesters.

Seed was metered out with a thimble seeder mounted on the side of the tractor. The tractor's track rotation drives the thimble seeder through a small rubber-tired wheel riding on the track. Changing thimble sizes and numbers compensates for variations in seed size, type, purity, and desired quantity.

After the thimble seeder meters seed, the seed is then dropped into a venturi tube. An airstream carries the seed to the discharge port behind the scalper. A turbocharger originally provided the air source. The turbocharger continued to blow seals, so an efficient 12-volt electric fan system was developed.

We evaluated the effectiveness of the scalpers in removing competing perennial grass (*Agropryon intermedium* and *A. desertorum*) and successfully establishing shrubs and forbs. The reinvasion rate and establishment of perennial grasses into the scalp determined success of each scalper. Seeding success was measured by counting the number of plants established per linear foot of scalp and by determining plant vigor by scalp type and species.

Perennial grass generally reinvaded from the edge to the center of each scalp. Where scalps were not deep enough to remove roots and rhizominous material, grasses also reinvaded from the bottom of the scalp. After the second growing season, the least amount of grass reinvasion and the most robust, vigorous seedlings were in the Seico fireplow scalps. Bordering and invading grasses produced competition that adversely affected seeded species in other scalp types.

After 2 years, the highest number of seedlings survived in the Sieco fireplow scalps. Species with more than five plants per linear foot were big sagebrush (*Artemisia tridentata tridentata*), mountain big sagebrush (*A. tridentata vaseyana*), prostrate kochia (*Kochia prostrata*), and showy goldeneye (*Viguiera multiflora*). Ladak alfalfa (*Medicago sativa*), Lewis flax (*Linum lewisii*), cicer milvetch (*Astragalus cicer*), and cliffrose (*Cowania stansburiana*) had two to five plants per linear foot. Species with less than two plants per linear foot were fourwing saltbush (*Atriplex canescens*), giant fourwing saltbush (*A. canescens [gigas]*), white rubber rabbitbrush (*Chrysothmanus nauseosus albicaulis*), mountain rubber rabbitbrush (*C. nauseosus salicifolius*), small burnet (*Sanguisorba minor*), and bitterbrush (*Purshia tridentata*). All except bitterbrush had acceptable plant numbers at the end of the second growing season.

After two growing seasons, big and mountain big sagebrush and white and mountain rubber rabbitbrush had grown exceptionally well. Prostrate kochia, showy goldeneye, Lewis flax, small burnet, and mountain big sagebrush all flowered and set seed during the second year. The sagebrushes, prostrate kochia, small burnet, Lewis flax, and showy goldeneye grew well seeded in mixtures.

Scalpers perform as desired with varying topography, soil and vegetative conditions when attached to the U.S. Forest Service-designed implement-carrying hitch. The thimble seeder is versatile because the seedling rate can be changed. Also, cleaned, trashy, dirty, plummed, rough, or smooth seed in any size will go through it. Seed can be transferred from the thimble seeder to the deposit point behind the scalper successfully with an airstream from a 12-volt fan or turbocharger.

Shrubs Can Be Transplanted Successfully with A Tree Transplanter

By Richard Stevens, Utah Division of Wildlife Resources, Ephraim, Utah

Funds were provided for this work by Federal Aid in Wildlife Restoration through Project W-82-R.

There are big game ranges, livestock ranges, and disturbed sites that require rapid establishment of desirable species and accessions. Tests over the past 3 years have demonstrated that transplanting shrubs and forbs with a tree transplanter is feasible. Initial results were reported last year and are included in this Workshop's 33rd annual report.

Excellent survival and growth have taken place where shrubs were hand placed by personnel riding a transplanter designed for hand transplanting. Most shrubs have multiple branching and fibrous or fairly large root systems. Consequently, shrubs are not picked up and released properly by automatic planting devices. Hand-fed transplanting resulted in over 80 percent survival after the second growing season compared to less than 30 percent survival with the same bare-root stock planted with an automatic planting device.

Four different types of tree transplanters were tested. A beefed-up Whitfield-type tree transplanter with a 28-inch V-shaped double sulky-type scalper, attached forward from the transplanter, produced the most acceptable survival rates. About 30 species (table 1) were transplanted with the scalper attached and about 30 transplanted with it removed. Transplanting directly into grass stands without first scalping resulted in poor survival (0-30 percent) for all species except mountain big sagebrush (*Artemisia tridentata vaseyana*). Survival of mountain big sagebrush in and out of the scalps was near 90 percent. However, plants in the scalps were 20 percent larger.

Bare-root stock (0-2) was transplanted much more successfully than container-grown stock. Likewise, bare-root stock generally grew better than the container stock. After 2 years, some container stock plants appeared to be somewhat stagnated. Some were dug up Most of those roots were still in the rooting medium and had not extended into surrounding soil.

Transplanting bare-root stock with roots from 6 to 12 inches long and tops at least 3 inches long was most successful.

The Forest Service-designed implement-carrying hitch performed an excellent job of transplanting at constant depths with varying topography, soil, and vegetative conditions.

Table 1.—*Species with over 75 percent survival 2 years after being transplanted into intermediate wheatgrass (Agropyron intermedium) with a modified Whitfield-type tree transplanter and scalper*

Amelanchier alnifolia (Saskatoon serviceberry)	*Elaeagnus angustifolia* (Russian olive)
Amelanchier utahensis (Utah serviceberry)	*Fraxinus anomala* (Single-leaf ash)
Artemisia cana (Silver sagebrush)	*Hedysarum boreale gremiale* (Utah sweetvetch)
Artemisia frigida (Fringed sagebrush)	*Kochia prostrata* (Prostrate kochia)
Artemisia nova (Black sagebrush)	*Lonicera tatarica* (Honeysuckle)
Artemisia tridentata tridentata (Big sagebrush)	*Peraphyllum ramosissimum* (Squawapple)
Artemisia tridentata vaseyana (Mountain big sagebrush)	*Penstemon palmerii* (Palmer panstemon)
Berberis fremontii (Oregon grape)	*Prunus americana* (American plum)
Ceratoides lanata (Winterfat)	*Prunus demissa*
Chrysothamnus nauseosus albicaulis (White rubber rabbitbrush)	*Prunus Lasciculata* (Desert peachbrush)
Chrysothamnus nauseosus salicifolius (Mountain rubber rabbitbrush)	*Prunus tomentosa* (Nanking cherry)
Cotoneaster acutifolia (Peking cotoneaster)	*Prunus virginiana melanocarpa* (Black chokecherry)
Cowania stansburiana (Cliffrose)	*Purshia tridentata* (Bitterbrush)
Ephedra nevadensis (Nevada ephedra)	*Rosa woodsii* (Woods rose)
Ephedra viridis (Green ephedra)	*Syringa vulgaris* (Lilac)

Transplanter used to plant shrubs in rangeland. It is attached to prime mover by USDA Forest Service-designed implement-carried hitch.

Improvements to the Rangeland Drill

By John Laird, Laird Welding & Manufacturing Works, Merced, Calif.

During the last year, rangeland drills have been furnished with a double shaft agitator to aid in feeding trashy seeds. The lower shaft has both right and left hand augers that move the seed to the fluted seed feeder. At the same time the top-shaft stirring rods keep the seed from bridging. Drills also have been furnished this year with the hydraulic-operated opener arms lift attachment. Both items are optional and can be added to an existing 8000 series drill. Also, the seed dribbler is still available with the universal mounting crawler tractor.

Adaptation of the Hansen Seeder and Sieco Fireplow to a Rangeland Interseeder

By Stephen B. Monsen, Intermountain Forest and Range Experiment Station, Boise, Idaho

In 1978 a prototype interseeder constructed by the Forest Service San Dimas Equipment Development Center was used to seed shrubs into about 580 acres of established stands of grass on rangelands in southern Idaho. Success of this machine as an interseeder has been reported by Stevens, et al. 1978[1] and Monsen, 1979[2]. The original machine was built using a Sieco fireplow to remove existing vegetation. A thimble seeder was used to dispense the seeds. Both attachments operated satisfactorily. The equipment was successfully used to seed shrubs into stands of grass or seed grasses and forbs into dominant stands of shrubs.

Based upon the success of the first prototype, attempts were made to adapt other seeders to this method of planting. The Hansen seeder-scalper was originally developed as an interseeder. The seeding mechanism was designed to handle a seed mixture consisting of various size seeds. This improvement has proven to be especially useful in seeding shrubs. The fireplow has proven to be the most efficient means of removing existing plants when interseeding. The seeding mechanism of the Hansen seeder was attached to the

[1] Stevens, Richard, 1978. Interseeder for rocky and brushy areas (ED&T 2432). *In*: 32nd Annual Report, Vegetative Rehabilitation and Equipment Workshop, Aug. 1978, p. 6.

[2] Monsen, Stephen B. 1979. Rangeland interseeder field trials. *In*: 33rd Annual Report, Vegetative Rehabilitation and Equipment Workshop, July 1979, p. 24-26.

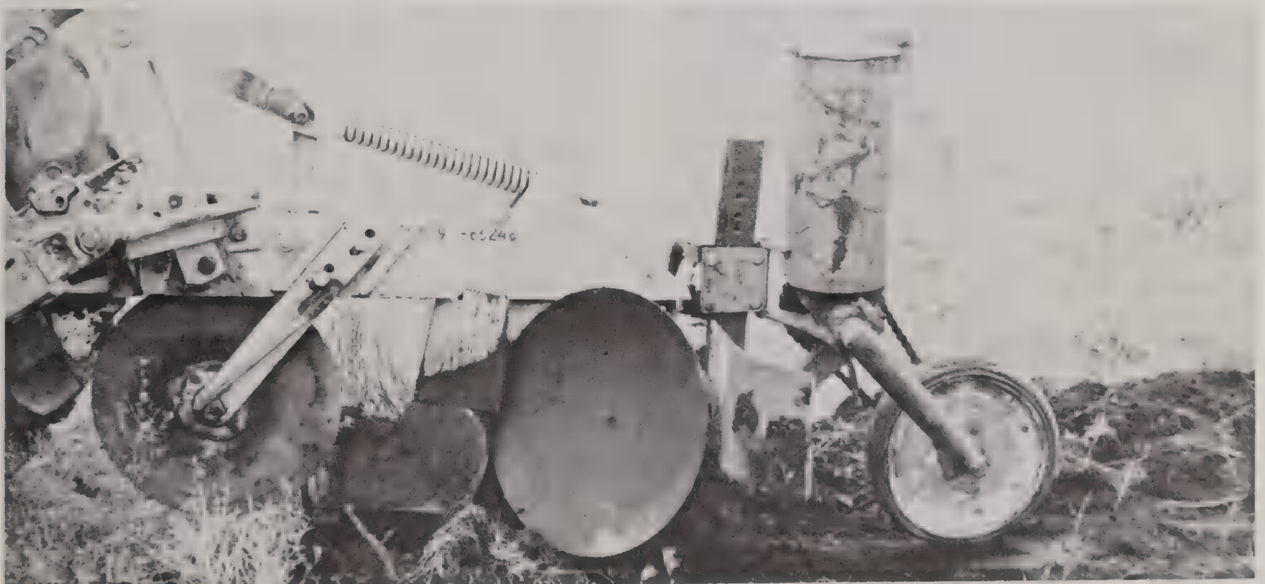
DOWN UP

Hydraulically operated opener arms lift attachment for the rangeland drill.

Sieco fireplow. Attaching the Hansen seeder to the fireplow produces a useful combination for interseeding. The Hansen seeder was easily attached to the fireplow by simply welding the two units together. Both machines are designed to allow for easy coupling.

The combined seeding unit was used to plant about 250 acres of Idaho rangelands in the fall of 1979. Plantings were made in areas where mature stands of crested wheatgrass (*Agropyron cristatum*) occurred. A mixture of shrubs consisting of fourwing saltbush (*Atriplex canescens*), big sagebrush (*Artemisia tridentata*), and rubber rabbitbrush (*Chrysothamnus nauseosus*) was planted. The machine operated satisfactorily. The unit is relatively maintenance free and can be used in most soils or land types. The unit was attached to a small John Deere 350 crawler tractor. The tractor had little difficulty in handling the seeder. The combined seeder was carried by the crawler tractor on a 3-point hitch. An implement-carrying hitch with a real hitch point to allow for better contour following on uneven ground would be more convenient, but is not necessary.

Use of the Hansen seeding mechanism offers some improvement over the thimble seeder. It is simpler to operate and requires much less time and expense for assembly. However, both seeders are satisfactory. The seeding portion of the Hansen seeder can be attached to the fireplow, and, yet, be removed for other use. If available, the Hansen seeder and fireplow can be easily coupled for use as an interseeder.



Sieco fireplow and Hansen seeder combined to serve as a rangeland interseeder.

Plant Materials

Gil Lovell, *Chairman*
(Reported by Wendall R. Oaks, SCS
Plant Material Center, Los Lunas, N. Mex.)

Two new drought-resistant grasses were released this year for soil stabilization, range reseeding, and surface mine revegetation. 'Viva' galleta (*Hilaria jamesii*) was released for use in seeding critical areas, especially range and coal mine reclamation areas. Viva is adapted to galletas natural range, which includes parts of west Texas, Wyoming, Utah, Nevada, Arizona, and California. Viva is drought resistant and survives well on arid ranges with annual rainfalls below 7 inches.

The second release is an introduced warm season perennial bunch grass from Turkestan, 'Ganada' yellow bluestem (*Bothriochloa ischaemum*). The full range of this drought-resistant grass is unknown, but successful plantings have been made as far north as Colorado Springs, Colo., at 6,000 feet elevation with 14 inch precipitation. Ganada yellow bluestem is valuable for revegetation of deteriorated rangeland or "go-back" lands.

Disturbed Land Reclamation (Western "Sub" Group)

Ron Younger, *Co-Chairman*

First, I wish to acknowledge the work that Don Calhoun, the previous co-chairman (Western Group), put in on workgroup activities. Don had a personal interest and contributed many hours on workgroup functions. I'm pleased to follow behind Don and to be associated with this workgroup for several reasons—the activities are directly associated with my present job responsibilities and the success of the work can be seen on the ground.

I also want to commend the personnel at the two Forest Service Development Centers for their work and efforts to keep the VREW workgroup chairmen informed and productive.

Our subgroup report will consist of several presentations:

Jim Smith, agriculture engineering at Colorado State University, Fort Collins, will describe a vertical axis rotary tiller they are working with.

Cal Kuska of Roscoe Brown Corp. will describe the operation of a pipeline backfilling machine that minimizes vegetation and soil disturbance.

Bob Knudson, project engineer at the Forest Service Missoula Equipment Development Center, will bring us up-to-date on some of the significant achievements completed last year on reclamation equipment.

Vertical Axis Rotary Tillers

By James L. Smith, professor, and Jon P. Workman, research associate, Department of Agricultural and Chemical Engineering, Colorado State University, Fort Collins; Kent A. Crofts, manager of reclamation and environment, Energy Fuels Corp., Steamboat Springs, Colo.

Introduction

This paper describes the vertical axis rotary tiller and presents the test results where the tiller was used for anchoring mulch and preparing a seedbed on topsoiled, recontoured mine spoil. The vertical axis rotary tiller has been discussed in the engineering literature for more than 50 years. However, successful commercial machines have been marketed for less than 10 years. Currently, all vertical axis rotary tillers are manufactured in Europe. They are available in widths from 4 feet to 18 feet.

Machine Description

Vertical axis rotary tillers (fig. 1) consist of three main elements: the stone bar (fig. 2), tillers (figs. 2, 3), and roller (fig. 3). The stone bar levels the soil and mulch layer, pushes many stones into the soil to be buried by the tillers and keeps clods , stones, and soil from being thrown forward.

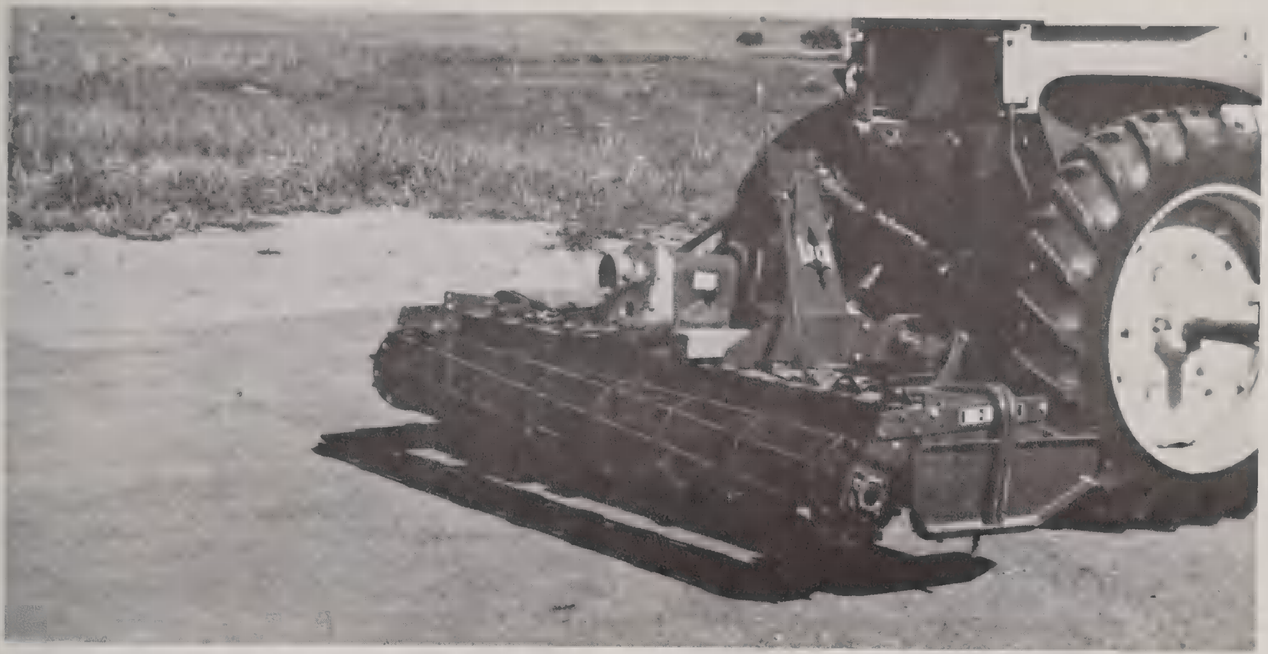


Figure 1.—Vertical axis rotary tiller.

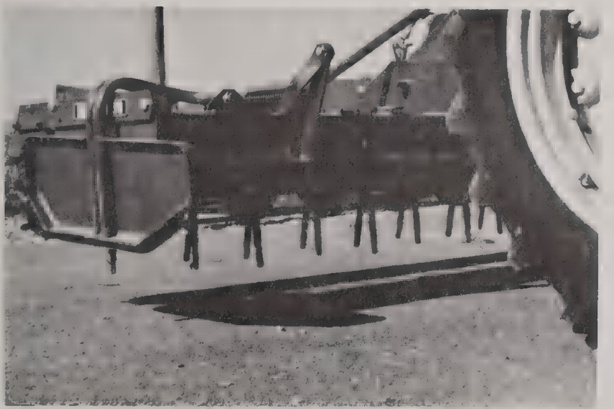


Figure 2.—Front of vertical axis tiller. Regular tillage tines are underneath. Stone bar is the horizontal member in front of and above the tines.

Figure 3.—Rear of vertical axis tiller. Mulching tines are in front of the roller.

The tillers are tines or knives that are essentially vertical and rotate with horizontal arms around vertical axes. In other words, tiller rotation forms a vertical cylinder much like a household electric mixer. A 10-foot vertical axis tiller has 14 pairs of tines. Each pair is mounted systematically on an arm and each pair rotates opposite to adjacent pairs. Alternative pairs of tines tend to throw soil forward and backward. This action produces uniform soil tilth with depth, levels irregularities, and buries about 70 percent of the rocks less than 8 inches in diameter.

Two types of tines are available. Regular or tillage tines are shown in figure 2, and mulching tines are shown in figure 3. Regular tines are slanted toward the rear so the bottom trails the top. This shape reduces the quantity of soil being thrown inside the tiller, improves mixing the soil, and aids in burying rocks. Mulching tines are bent 90° toward the axis of rotation at the lower end. This shape aids in pulling straw or hay into the tilled soil layer. Based on experience, a set of worn tillage tines will anchor mulch as effectively as mulching tines.

The roller consists of 6 to 12 rods mounted on the periphery of 12-inch-diameter flat plates in the form of a horizontal cylindrical cage. Individual rods extend over the width of the machine and are mounted to form a helix. This shape provides a smooth rolling motion. The roller packs the soil, confines soil in the tillers, breaks large clods that pass through the tiller or are thrown against the rods, and controls the operation depth of the tillers. For reclamation purposes, a roller with six larger diameter rods would be satisfactory. It would be advisable to redesign the roller frame and attachment so the operation depth of the tillers could be easily adjusted.

Field Tests

A Lely model 300-30, 10-foot-wide, vertical axis tiller supplied by Lely Southwest, P.O. Box 1026, Temple, Tex. 76501 (817) 938-2564, was used in tests conducted at the Kerr Mine near Walden, Colo., and on the Colorado State University campus. In side-by-side tests with a mulch crimper and horizontal axis rotary tiller, the Lely machine did a superior job of anchoring grass hay mulch applied irregularly at an average rate of 3 tons per acre. The Lely evenly distributed the mulch and produced a unifrom compact seedbed. Soil particle size varied uniformly from fine particles to clods about 1½ inches in diameter above a depth of about 4 inches, the operation depth of the machine. Two passes were made, one perpendicular to the hay application direction and one parallel to the hay application direction. This was also done with the mulch crimper and horizontal axis rotary tiller.

Mulching tests conducted at Colorado State University with grass hay applied nonuniformly at 3 tons per acre are illustrated in figures 4 and 5.

The speed of the tillers can be set at 265 rpm, 298 rpm, 333 rpm, 376 rpm, or 480 rpm with a 540 rpm tractor pto speed by changing the gear sets in the drive system. The relationship of forward tractor speed to rotating speed is critical for good anchoring of mulch. A forward speed of slightly less than 4 mph was found to work best with a tiller rotating speed of 480 rpm. Faster forward speeds caused the mulch to collect in front of the stone bar. Slower forward speeds caused the mulch to be thrown through the machine. Faster forward speeds could probably be used if the stone bar was redesigned so it could pass over large bunches of mulch.

Major advantages of the vertical axis tiller compared to the horizontal axis tiller are its lower power requirements (about 30 percent less), more compact size, capability to level soil and evenly distribute mulch, and superior seedbed preparation. The vertical axis tiller could be used with a mulch spreader, rangeland drill, or other machine in a single-pass operation. A small hydraulically powered vertical axis tiller could be mounted on a telescoping crane to till, fertilize, and seed steep slopes.

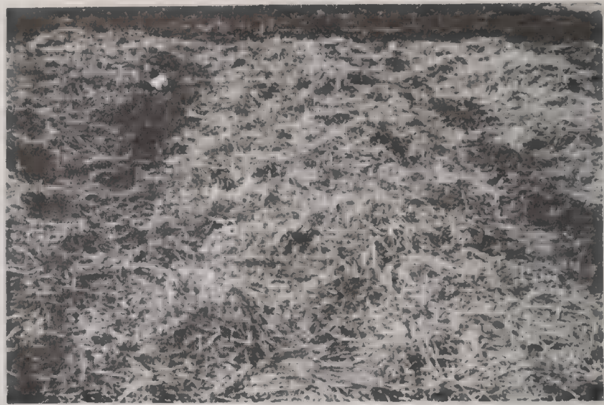


Figure 4.—Grass hay spread at 3 tons per acre.

Figure 5.—Grass hay anchored with vertical axis tiller.

A moderate number of rocks up to 10 inches in diameter had no apparent effect on the vertical axis tiller. In fact, most loose rocks were buried by the machine. However, it is recommended that the shear pin used to protect the drive train should be replaced by a slip clutch or similar mechanical device for reclamation use. In tests at the Kerr Mine, no problems or stoppages were encountered with the tractor pto clutch adjusted to slip when the tiller hit large objects. However, with the pto clutch properly adjusted, several shear pins were broken.

Summary

The vertical axis rotary tiller produced superior results in field tests compared to the mulch crimper and horizontal axis tiller. The vertical axis tiller has many applications for reclamation and revegetation tillage and mulching. Redesign of some tiller components would improve their suitability for reclamation or revegetation work.

Minimizing Vegetation and Soil Disturbance in Pipeline Construction

By Calvin Kuska, Roscoe Brown Corp., Lenox, Iowa

A horizontal earth auger has been developed that minimizes vegetation and soil disturbance along a pipeline right-of-way (R-O-W) (fig. 1). The auger also minimizes damage to the anticorrosion wrap and the cathodic wires used to reduce failures from corrosion in the line. The auger requires only one-third the width that a dozer requires to perform a backfill operation and is 10 times faster than conventional shuttle backfilling with a dozer.

An increasing number of underground gas and water lines are crossing public lands. Therefore, particular attention must be given to engineering specifications and inspection to insure that the proper methods and equipment are being used by contractors. This control of methods and equipment can greatly minimize vegetative and soil disturbance.

The auger backfiller operates parallel to the trench, working entirely within the width of the windrowed spoil. There are two basic types of these augers: a side discharge unit and a center discharge unit. The side discharge unit fills from one side of the trench; the center discharge unit straddles the trench and is only used when the spoil is on both sides of the trench.

Both designs provide the same backfilling action. The auger rotates in a reverse direction to travel into the spoil pile. This can be either trencher or backhoe dug. The material is pulverized, and the wet material is aerated and dried. The flights of the auger raise the rocks momentarily while the fine material flows in first at a distance of 5 to 6 feet ahead of the auger. The material flows equally to both sides of the pipe in an apex, causing the pipe to remain in place during the backfilling. Using this manner of entry, the pulverized material has time to flow in and around the pipe, providing the necessary support and padding to prevent shifting. Shifting could create cracking of plastic lines or failures of welds when the total weight of the material is deposited on the line.

Figure 1.—Horizontal earth auger backfilling machine.

Figure 2 shows the filling action that makes the difference between auger and dozer backfilling. The material is flowing out ahead rather than being shoved over the side with the dozer and dumped on the pipe. The trench is properly filled before the weight of the machine can cave in the sidewall. Any rocks sitting on the trench edge are not pushed in ahead of the spoil to cause denting or collapsing of the pipe or fracturing of the anticorrosion wrap.

In many crop situations of vegetative environments the auger operator can sweep the spoil off of the standing vegetation. The only actual vegetation loss requiring reseeding is in the width of the trench which is only a small part of the R-O-W. In areas where the topsoil must be saved and replaced, the auger can be used for removing the topsoil before trenching. The material is windrowed evenly; and the average auger unit can strip up to 3,000 cubic yards per hour. The speed of this operation is just under 1 mph with a cost of moving this material of about 2 cents per cubic yard.

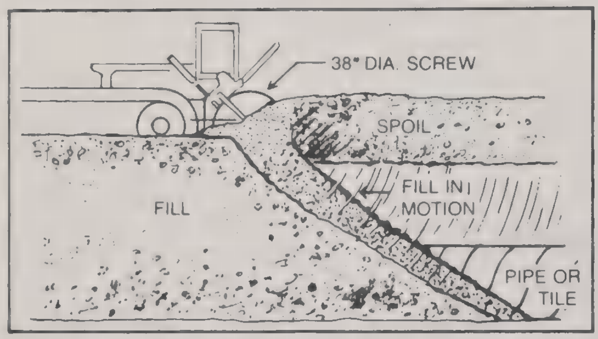


Figure 2.—Backfilling action with horizontal earth auger.

When pipelines cross irrigated land there is usually a requirement for water consolidation to prevent water channeling down the furrow. With the auger, the operator can make the first pass partially backfilling the furrow. This forms a level-bottomed furrow that requires a minimum amount of puddling water. After settling, the operator can make the final pass and fill the trench.

All of this backfilling is accomplished without shuttling out and in across the R-O-W. The coverup forms in a uniform, continuous ribbon without clumps, peaks, or valleys of material that are readily apparent after a dozer or blade has moved the spoil.

Figures 3, 4, 5, and 6 show the auger backfiller working on a pipeline crossing public lands in Montana. The backfiller in figure 3 is moving forward at nearly 1 mph. Rocks dug out by the trencher are being safely returned to the trench in figure 4, because the fine material has already covered the pipe with a protective envelope. Figure 5 is a rear view of the auger machine and shows its sweeping action. Very little vegetative damage is caused by the rubber-tired earthmoving machine. All material from the trench is placed back over the pipe, and is not left in the spoil pile or thrown to the opposite side of the ditch.

Figure 3.—Earth auger backfilling pipeline trench at 1 mph.

Figure 4.—Rocks dug out by the trencher are safely returned to the trench because the fine material has already covered the pipe.

Figure 5.—Rubber-tired machine causes little vegetative damage and sweeps all material from the trench back over the pipe.

Figure 6.—Operator uses tire to pack down material, eliminating crown and speeding consolidation.

In figure 6, the operator is using the tractor tire to pack. This reduces the crown and speeds consolidation. If desired, a drop hammer can be attached to the rear of the tractor for compacting; it can be interchanged quickly with a hydraulic backhoe that can be used by the contractor for tie-ins.

This same auger is used to prepare the R-O-W in those areas where sagebrush (or other tall vegetation) must be removed for access by the construction crew. When double ditching is required, the auger can accomplish this while providing proper backfilling. When the job is completed, the same auger can be used to respread vegetation for possible reseeding. Normally a motor patrol has to be brought in to accomplish this clean-up.

Besides backfilling, the auger can be used for construction of berms and terraces, for borrow aeration, for removing silt from ditches, and for some grading.

The auger is hydrostatic propelled. Its speed can be set higher for shedding wet material and set slower for sandy and rocky conditions. The machine is simple in design, and maintenance is minimal. The parts that wear (the replaceable and adjustable plates on the lead edge of the auger) are under patent to the manufacturer.

The development of the auger led to the development of a four-wheel hydrostatic propulsion unit that has provisions for hydrostatic implement drive. This eliminates the need for an independent power unit for an attachment.

The tractor has crab, coordinated, and front steering, with no-spin in the rear axle. Axles have planetary drive and the rear axle oscillates 15 degrees. Other units that interchange in 20 to 40 minutes with the auger and are useful to contractors include hydrostatic snow blowers, hydrostatic sweepers for clearing snow off archaeological formations, hydrostatic brush shredders, brush rakes, angle dozers, V-plows, forklifts, side booms, winches, and trenchers.

The tractor and some of the attachments are manufactured by Roscoe Brown Corp, P.O. Box 48, Lenox, Iowa 50851 (515) 333-4353. A companion tractor to the Brown Bear, which has 160 or 225 horsepower is the Brown Bear Club. This has 95 and 150 horsepower and much of the same versatility; the features are basically the same.

Equipment Development Projects for Disturbed Land Reclamation

By Robert Knudson, Forest Service, Equipment Development Center, Missoula, Mont.

In the last 2 years, work was completed on four projects at the Forest Service Missoula Equipment Development Center (MEDC). The projects were funded by the Bureau of Land Management under its EMRIA (Energy Mineral Rehabilitation Inventory and Analysis) program. The projects were ED&T 2629, Soil Conditioner for Disturbed Land Revegetation; ED&T 2630, Transplanter for Disturbed Land Revegetation; ED&T 2631, Gouger for Disturbed Land Revegetation; and ED&T 8041, Basin Blade. Reports and drawings for the equipment built under these projects are available from the Missoula Center.

The Center is currently funded by the BLM for four additional projects related to disturbed land revegetation. The following brief outline of each project describes the problem to be solved, the project goal, prior work done, if any, and project objectives.

Sprigger for Native Shrubs (ED&T 9120)

Problem. Western States have stipulations in their mined land rehabilitation laws that require revegetating disturbed surface lands with native vegetation. This is most easily done by sowing the seeds of native plants. However, because of the harsh sites and the frequent drought conditions found in the western coal areas, this technique often results in failure. It is now possible to buy containerized native plant material from commercial growers but the cost may be too high for large-scale planting. In most cases native plant material is already growing on the site or nearby. This is an ideal source of planting stock because its suitability for surviving in the area has been proven. The problem is to successfully transplant the material.

Goal. The goal is to make available equipment and techniques that will allow the efficient movement of native vegetation for disturbed land revegetation.

Prior Development. Dick Hodder, Montana State University, has conducted experiments to test the feasibility of extracting large numbers of stems or sprigs from rhizomatous plants for mine land revegetation. The sprigs are simply spread out on the area to be revegetated and covered with soil. The tests indicate that this method can be used successfully if equipment

is developed to make the process efficient. MEDC began working on this project in FY 1979. Criteria for the sprigger were established and a market search was conducted to determine what commercial equipment was available to modify for this use. A commercial rock picker of the potato digger type was purchased and tested. Independent conveyor vibrators were added for improved soil-root separation. Chisel plow shanks were mounted ahead of the under cutter blade to loosen the soil. A small manure spreader was purchased and modified for use as a sprig transport and planter. Testing in FY 1980 will show the final system configuration.

Project Objectives. In FY 1981 testing and final drawings, specifications, and a report are planned. Project work and documentation will be completed in FY 1982.

Sprigger digs up root systems . . .

then deposits them into sprig spreader.

Small-Diameter Well Water Sampler (ED&T 0436)

Problem. Many water samples are taken at mine sites to determine water quality at various locations on the site and effects of mining on the different aquifers. Current practice is to drill test wells and push down 4-inch-diameter casings. A submersible pump is lowered into the well and the water sample is taken. Air cannot be used to pressurize the casing and force the water up a tube because this would affect the dissolved oxygen content of the water sample and oxidize some of the compounds in the water. If a method could be developed for getting satisfactory water samples from wells with smaller casing pipe, the cost of drilling test wells could be reduced.

Goal. The goal is to reduce the cost of obtaining mine site subsurface water samples.

Prior Development. A sampler was developed by Bernie Jensen of Reclamation Research, Montana State University, for sampling water from the 4-inch-diameter wells. But nothing is available for small-diameter wells. In FY 1980 a market search will be made to see what is available for small-diameter water pumps.

Project Objectives. In FY 1981 a final concept proposal will be chosen for development. A prototype will be built and tested and modified if necessary. In FY 1982 a commercial source for the prototype pump will attempt to be found. It should be determined by this time what market will be available for the small pump. A sampling system will be developed for the pump and the system tested and modified.

Dryland Plug Planter (ED&T 8042)

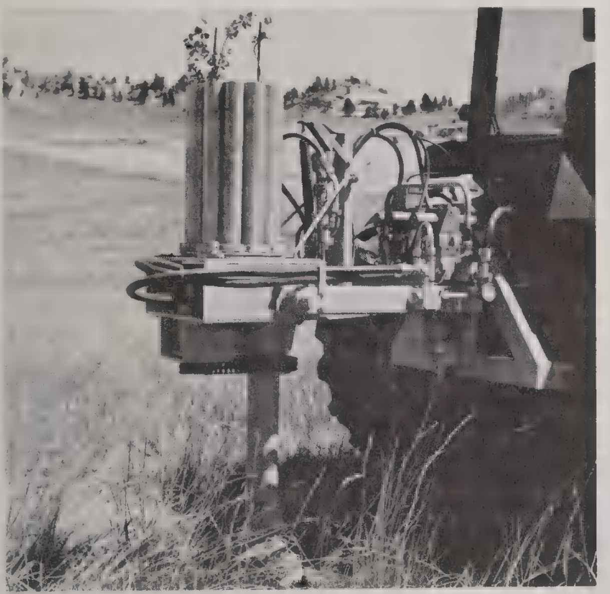
Problem. Planting of trees and shrubs on reclaimed strip mined lands in the Western United States has generally not been successful. In the process of lifting bareroot stock from the nurserybed, most of the fiberous roots are destroyed. This greatly reduces the plant's ability to take up moisture and nutrients from the soil after being planted. On forested sites where bareroot stock is commonly planted, there is usually sufficient soil moisture to get the seedlings through the first growing season. On reclaimed mined sites in semiarid locations this is not the case. Techniques such as container planting must be used to improve survival. The problem is that hand planting of large containerized stock (18- to 24-inch-high containers) is difficult and very slow. A mechanized system is needed to plant reclaimed sites with large containerized stock.

Goal. The goal is to make available a dryland plug planter that can be used to successfully establish containerized trees and shrubs on reclaimed sites subjected to harsh growing conditions.

Prior Development. Personnel engaged in mine land revegetation are beginning to experiment with plug planting in the Western United States. Early results

indicate that containerized stock, properly used, can speed up revegetation and reduce costs because of better survival. To date, however, all plug planting on reclaimed land has been done by hand. A number of automated plug planters are currently being developed for forest planting but these machines are all designed to use small plugs (2 to 8 cubic inches). In FY 1978 MEDC began this project by meeting with experts to determine the criteria for a dryland plug planter. With that established, the design of a prototype model was begun and essentially completed before the end of the fiscal year. In FY 1979 the prototype machine was built and tested. Redesign was necessary and additional tests will be conducted in late FY 1980.

Project Objectives. In FY 1981 the final modifications will be made to the tubeling planter. Plant material will be ordered for spring 1981 planting. Data on tree survival will be followed up, a final report made, and project ended.



Plug Planter.

Dryland Sodder (ED&T 8046)

Problem. One of the greatest concerns land managers have regarding reclamation of strip mined areas is replacement of topsoil on reshaped spoil material. No method has been found that allows the topsoil to retain its structure if it is moved. Topsoil has very definite gradients of organic matter, nutrients, microorganisms, and toxic materials. All the methods now used to segregate topsoil from subsoil destroy the gradients naturally found in the topsoil. Preservation of the topsoil, with its structure intact, would be a tremendous advance in reclaiming strip mined lands.

Goal. The goal is to make available to land managers a method of moving topsoil while preserving its structure.

Prior Development. In FY 1978 Center engineers conducted a market and literature search to determine what commercial equipment was available to modify and use as a dryland sodder. From this information several concept designs were made and evaluated by the sponsor. A modified front-end loader bucket was selected as the first prototype dryland sodder. In FY 1979 a dryland sodder was designed and constructed, and testing was begun. Modifications were made to the machine in FY 1980 and testing was completed. Drawings, specifications, and a final report were prepared to terminate the project.

Dryland Sodder.

Disturbed Land Reclamation
(Eastern "Sub" Group)

Willis Vogel, *Co-Chairman*

(Reported by Ron Younger, BLM)

Two meetings of national scope related to mined-land reclamation took place in 1979. The first, the coal conference and Expo V was held in Louisville, Ky., in October. This conference was sponsored by McGraw-Hill, publishers of *Coal Age*. Advance publicity on this meeting was lacking and attendance less than anticipated. There were a limited number of papers on reclamation.

In December 1979, a symposium on surface mining hydrology, sedimentology, and reclamation was held in Lexington, Ky. It was sponsored by the University of Kentucky with assistance from several professional societies, Office of Surface Mining, and U.S. Department of the Interior. This symposium included a series of minicourses plus about 50 papers on the subjects of reclamation, hydrology, and sedimentology. Copies of the proceedings are available from the Office of Engineering Services Publications, College of Engineering, University of Kentucky, Lexington, Ky. 40506. A call for papers has been announced for a similar symposium to be held in Lexington, Ky., December 1-5, 1980.

Mulching Machine Conversion from A Rotary Feed Grinder

By Bob Anderson, Lo-Co Equipment Co., Windsor, Colo.
(Presented by Ron Younger, BLM)

Equipment needed for special uses often is developed by imposing modifications on existing standard equipment. The need for a mulching machine capable of handling 1,500-pound round bales of straw and hay motivated two mechanics at an Ohio coal mining company to develop such a machine. They modified a rotary tub grinder that normally is used for grinding cattle feed.

This mulching machine, called the Roto-Grind-Mulch Master, is now commerically available from its manufacturer, Burrows Enterprises, 6340 West 10th, Greely, Colo. 80631, (303) 353-3769; and a distributor, Lo-Co Equipment Co., 29774 Weld County Highway 257, Route 1, Box 40, Windsor, Colo. 80550, (303) 686-2110. The mulcher has been in use for about 1 year, and in 1979, about 25 units were sold in several States from Wyoming to Alabama. Most of these units have been sold to mining or reclamation companies for mulching reclaimed mined lands. Cost of the machine as of March 1980 was $9,140 fob Colorado, Wyoming, or 300 miles of Greely, Colo.

The Roto-Grind Mulcher is a simple machine with just two operating parts—the feeder tub or hopper and the beating blower. The hopper at the top of the machine is 9 feet in diameter and 42 inches deep. Mulching material is dumped into the hopper with a front-end loader. The mulcher handles large round bales, square bales, and loose hay and straw. Strings can be left on the bales. The mulcher also will spread bark, wood chips, composted municipal wastes, and all types of crop residues.

The beater-blower combination mounted beneath the hopper beats the materials and throws the ground-up material out of the machine. The beater-blower contains hammers. Removing part of the hammers reduces horsepower requirements and produces a coarser mulch. Wires and small foreign objects won't hurt the machine, but, as with other types of mulchers, these objects can be lethal projectiles when thrown from the discharge chute.

Roto-Grind mulcher.

The ground material is discharged from the left side of the machine. The mulcher is equipped with a skid plate to protect it when dragging over rocks. The flow of material from the blower can be directed up or down to some extent by adjusting discharge control plates at the mouth of the chute.

On the average, 40 to 60 1,500-pound round bales can be applied in an 8-hour day. Larger amounts can be applied under ideal operating conditions. One contractor in Ohio claims to have applied 200 bales in 1 day. The maximum blowing distance is 60 to 70 feet, depending on type of material, tractor pto speed, wind conditions, etc.

Mulch is applied evenly. The amount applied per acre can be regulated by the tub turning speed and the tractor ground speed. The tub speed can be controlled by a lever on the machine. The tub can be stopped from the tractor. Stopping the tub also stops the mulch spreading.

A 100-horsepower tractor with a 1,000 rpm pto is required to operate the Roto-Grind Mulcher, although some users prefer a 130-horsepower tractor. One person can run the entire mulching operation if necessary. But two people increase the efficiency—one person on the loader and one operating the mulcher.

Seed Harvesting

A. Perry Plummer, *Chairman*

(Reported by A. Perry Plummer, Forest Service, ret., Provo, Utah; Stephen Monson, Forest Service, Boise, Idaho; Richard Stevens, Utah Division of Wildlife Resources, Ephraim, Utah; Claire Gabriel, Native Plants, Inc., Salt Lake City, Utah)

If we are to successfully carry out wildland planting we need plant seeds. The seeds required are those of many kinds adapted to a wide range of wildland sites. These vary from highly diverse, severely disturbed areas of a few acres to extensive rangelands of many thousand acres.

There is strong demand for seeds of adapted native plants. However, in some instances, naturalized introductions are being justifiably used. Through the years they have been planted with amazing success. Other introductions are showing important adaptation for extended planting. These are mainly grasses harvested from agricultural land by farm combines.

Our concern here is with efficiently getting plant seeds not in this category. We hope many will be grown on agricultural land. Certainly some will be, but some may never be. This is because of the nature of their growth characteristics and sometimes lack of adaptation to agricultural lands.

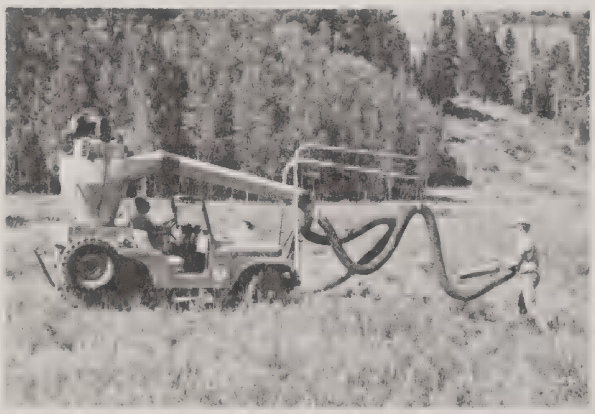
In some instances, demands are of a specialized or restricted nature requiring seed only from plants occurring on their native habitat. Even though some plants grow well on farm lands, their maturity characteristics are not suited to harvesting by farm equipment. Important among these are shrubs, trees, forbs, and some grasses. For these classes of plants we urgently need specialized equipment so we can better harvest the seeds, whether on wild or agricultural lands.

During the past 15 years, some important progress has been made. We are on the threshold of some important new developments. To a considerable degree, our progress is attributable to engineers of the San Dimas Equipment Center working with people in the field. We have to give a great deal of the credit for this to Dan McKenzie. Certainly more would have been done if more money and encouragement had been given to the Equipment Center for this purpose.

We do not minimize the ingenuity of seed collectors in the field, who by their own ingenuity and hard work have devised equipment to accomplish harvesting. This is where we get most of our native plant seeds. Important among this equipment are various types of shoulder hoppers, paddles, and pickers and other hand devices so that a man by himself can collect sizable amounts of seed.

Testing vacuum seed collector concept, San Bernadino National Forest, Calif., July 1961.

Jeep-mounted vacuum seed collector being tested at the San Dimas Equipment Development Center before field testing, June 1963.



Jeep-mounted seed collector operating near Ephraim, Utah, September 1963.

Truck-mounted vacuum seed collector operating near Capitan, N. Mex., November 1968.

Backpack vacuum seed collector, 1977.

As the program developed for better equipment, it was conceived that vacuum-type seed harvesters were the way to go. This provided need for selectivity in getting seed from mixed species stands, as well as getting seed from plants having differing maturity dates. It was learned early that seed of most species had to be separated from the airstream before passing through the impellor; that inlet velocity of suction tubes must equal 7,000 feet per minute; tube inlet size has to be about 6 inches.

With these principles in mind, a successful seed vacuum harvester was built with two 6-inch hoses. The machine weighed about 1 ton. It was mounted on a 2-ton truck, and custom built for $4,000. This machine was purchased by the Southwestern Region of the Forest Service. During a period of years, it was used to harvest several thousand pounds of seed from fourwing saltbush, true mountain mahogany, winterfat, and cliffrose. A major handicap is that its use was confined to relatively flat land where a truck could operate.

It was evident that to get seed from rough and uneven lands, a harvester that a man could carry on his back would be required. So in recent years (since 1975), the development and perfection of such a machine has been under way, and some important progress has been made. Two of these machines have been manufactured. Additional changes are necessary to make them usable. A major revision is to reduce the weight from 44 to 34 pounds and reduce the engine noise.

Collecting forb seeds at Ephraim, Utah, with air amplifier seed collector.

In addition, some investigation and inquiry was done. Based on the former criteria, the use of an injector seed-collecting head (air amplified) powered by compressed air was developed. This required a hook-up of the hoses to a portable air compressor. This limits the use of the machine to flat areas or where the compressor can be pulled by a vehicle. The technique appears applicable on several species, especially those producing fluffy seeds and those having spiney bushes such as shadscale saltbush.

Another approch uses a seed collecting head on the intake of an air broom. This appears to be the means by which an efficient, really lightweight machine can be developed. We are placing a lot of hope for the future on this machine.

Oklahoma State University Seed Harvester Development

The Oklahoma State University grass seed stripper is now being manufactured by the Kincaid Equipment Manufacturing Corp., P.O. Box 471, Haven, Kans. 67543, (316) 465-2204.

This unit strips seed from the plants by a rotating drum with nylon flails. Because the seed canopy is not cut by a sickle, only a small amount of stems and leaves are taken into the harvester, resulting in fairly clean seed. The cost of the OSU seed harvester, as of March 1980, is $9,600, fob Haven, Kans.

Kincaid model 110 grass seed stripper. Machine is the result of research and development work by the Agricultural Engineering Department, Oklahoma State University.

Steep-Slope Stabilization

Lou Spink, *Chairman*

Steep Slope Seeder

As 1978 tests on the Willamette National Forest in Oregon were satisfactory (see 33rd annual report), we did not further refine the steep slope seeder. The seeder was left with the Willamette National Forest for operational use after testing was completed.

In 1979, at the request of the Willamette National Forest, the Forest Service San Dimas Equipment Development Center (SDEDC) modified the seeder so it could be used either with a gradall, as originally designed, or towed behind a tractor. The "towed" option was desired for seeding ski slopes. The modification also includes a set of pneumatic-tired wheels that can hydraulically lift the seeder so that it can be towed on roads or other hard surfaces.

This towing modification worked well at SDEDC, but the Willamette has not yet used it. Data on its use will be gathered in 1980, and included in the next annual report.

Tree/Shrub Planter

The tree/shrub planter digs a hole with an auger, drops a seedling from a carousel-type container, and then compacts the soil around the planted seeding. To increase the planting rate, the planter was designed with two sets of planting equipment—auger, carousel, and compactor—one at each end of the frame. However, the pre-prototype planter was equipped with only one set of planting equipment for demonstrating the concept.

The pre-prototype was tested on the Willamette National Forest in 1979. These tests showed that the concept was satisfactory, and further refinement is unnecessary. However, the final fabrication drawings for the "double" planter were not completed by the end of FY 1979, and no funds were allocated for this project in FY 1980. No work will be done or planned on this project until funds are available.

Steep slope seeder.

Thermal Plant Control

Bill Davis, *Chairman*

Thermal Brush Control (ED&T 2168)

Recommendations made at the 1977 annual meeting were to continue testing and construct a new lightweight machine.

Committee members now concede that the current petroleum situation lowers the priority for continuance of the propane burner project. Therefore, we recommend that the propane burner project be discontinued until circumstances dictate otherwise.

Aerial Burning Equipment for Plant Control (ED&T 2627)

An improved aerial ignition system is now operational. The "helitorch" is being manufactured by Simplex Manufacturing Co. of Portland, Oreg., for the Western Helicopter Services, Inc., of Newburg, Oreg. The helitorch is an efficient tool where speed and inaccessible terrain are concerned. Denny Bungarz, fire management officer, Mendocino National Forest, Calif., reports on the operation of the helitorch on page 45.

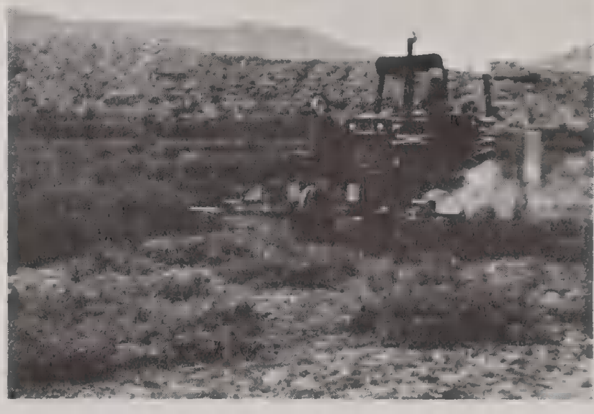
Assessment of High Voltage Electricity for Brush Control

By Thomas H. Shrader, Water and Power Resources Service, Rio Grande Project, El Paso, Tex.
(Presented by Dan McKenzie, Forest Service Equipment Development Center, San Dimas, Calif.)

The Rio Grande Project of the Water and Power Resources Service (formerly Bureau of Reclamation), Department of the Interior, is responsible for controlling regrowth of woody vegetation on selected portions of the Caballo Reservoir floodplain in New Mexico. The principal purpose of the program is to conserve ground water that might be lost through transpiration by woody phreatophytes. With the restriction on herbicides by the Federal Environmental Pesticide Control Act of 1972, and limitations on ground-destructive mechanical control methods such as root plowing, the project has used mowing to reduce the regrowth of saltcedar (*Tamarix chinensis* Lour.), seepwillow (*Baccharis glutinosa* Pers.), and a few honey mesquite (*Prosopis glandulosa* Torr. var. *glandulosa*) and screwbean mesquite (*P. pubescens* Benth.) plants. A second benefit from the control program is livestock grazing.

To obtain better control without chemicals and soil-damaging mechanical methods, the Rio Grande Project contracted with a private company during 1977 to demonstrate the potential effectiveness of high voltage alternating current (ac) to control woody plant species. For the demonstration, on an infrequently flooded portion of the Caballo Reservoir floodplain, 50- and 200-kilowatt (kW) generators produced the ac. The high voltage units were composed of an electrical generator driven by a tractor pto or separate engine and a transformer to raise the voltage, usually at a 60:1 ratio.

The ac can be applied to target plants by any good conducting material. In this demonstration the energized applicator was stainless-steel pipe 20 and 18 feet in length for the 50- and 200-kW units, respectively. The 50-kW unit was operated off the pto of a 100-horsepower farm tractor. The 200-kW unit was mounted on a logging skidder with a self-contained power source.



The 50-kilowatt, high voltage ac plant control unit mounted on a farm tractor.

The 200-kilowatt, high voltage ac plant control unit mounted on a log skidder.

(For additional information, see "Brush Control with Electric Current" in the 32nd VREW annual report, page 25.)

To damage a plant, the energized treatment bar must contact the target species. The ac will not arc or jump to a plant. Some arcing will occur once a plant has been contacted. Once contacted, the electrolytic solution of the plant will conduct the current. This causes a rapid temperature rise and vaporization of the plant's liquid phase. This ruptures cell walls and destroys the vascular system. With enough contact time and energy, steam is visible from the rupture. Also, vaporization of succulent plant tissues occurs, along with the splitting of bark.

Electrical applications were made to the four plant species with the 50- and 200-kW units during May 25-27 and August 8-12, 1977, respectively. All treatments were made to the regrowth of plants following their mowing to a height of 6 to 10 inches that winter or the early summer. In some cases, the plant regrowth following the initial May treatment was treated a second time with the 200-kW unit. Regrowth height at the time of treatments varied from 1 to 8 feet. The plant age ranged from 1 year for seepwillow to more than 10 years for saltcedar.

Due to nearly two decades of control by mowing, the plants have a somewhat prostrate, thickened base and crown from which 1 to 30 shoots may sprout. The smallest number of resprouts is produced by seepweed and the most by saltcedar. The number, thickness, and biomass of the large numbers of saltcedar resprouts influenced the effectiveness of treatments.

In addition to growth-stage and species, other variables in the evaluation of the ac systems were application speed (about 1.8 and 2.3 mph), number of passes over the same plants (one or two), voltage delivered to the plants (10,000 or 15,000 volts), and power density (2.5 kW per foot of treatment bar for the 50-kW unit or 11 kW per foot of treatment bar for the 200-kW unit). Combinations of these variables were used to evaluate treatments. Approximately 100 acres were treated with the 50-kW and 200-kW units. Check plots were mowed in June and September.

Based on a visual evaluation of both treatments, the high voltage ac treatments, except for the kill of a few young and solitary seepwillow plants, caused results that were comparable to an effective searing with LPG. Of the variables evaluated, the combination of slow application speed (greater treatment time), high voltage, double passes (two passes over a plant in opposite directions), thin stands of vegetation, and young succulent growth resulted in the most complete top kill of saltcedar, mesquite, screwbean, and older, denser stands of seepwillow plants and the complete kill of a few young, isolated seepwillow plants that received the full or nearly full dosage of the ac charge. Established plants of the four species resprouted and displayed normal growth following the death of treated foliage and branches.

It took 10 to 14 days before the effects of the ac treatments would appear on saltcedar and the *Prosopis* species. The young, succulent shoot growth of seepwillow wilted immediately following treatment. The young cambium turned a tobacco-stain brown within 1 or 2 days and the treated stems died within 3 to 4 days. Foliage of saltcedar and the *Prosopis* species first turned yellow above the point of stem contact by the treatment bar, followed by partial or complete yellowing below the point of bar contact. When the 50-kW unit was used to treat dense, shrubby saltcedar, it killed upper portions of stems. The lower portions produced new lateral growth that apparently indicated a decline in high voltage effectiveness through dilution of ac dosage with increasing biomass (increasing cross-sectional area). This response was found less with the 200-kW unit. Prostrate or short stems that the energized bar did not contact were not harmed because the ac took the path of least resistance to ground.

The high voltage treatments were least effective in dense homogeneous or mixed stands of the species and in individual, dense shrubby plants. In such dense situations the ac would have a tendency to do two things: (1) the current would tend to bleed off through the most succulent, least resistant stems or species, thereby drawing current away from otherwise more resistant stems or species; and (2) the treatment bar would push the plants over, causing the prolonged contact of stems or branches nearest the energized bar while pushing vegetation on the opposite side of the plant away from the treatment bar, killing only one side and parts of the plant top. A slower treatment speed (longer contact) helped solve the former problem. A second pass in the opposite direction generally overcame the latter problem. One additional problem was arcing, which tended to ignite several fires in the dry debris left from previous mowings.

In summary, the high voltage ac units reduced aboveground stem and foliage growth but could not control resprouting by established plants.

Mechanical Plant Control

Loren Brazell, *Chairman*

Madge Rotoclear Machine

By William E. (Ed) Dick, sales manager, Can-A-Mex Manufacturing, Ltd., Calgary, Alberta

Can-A-Mex Manufacturing, Ltd., of Calgary, Alberta, manufactures a heavy-duty rototiller and land clearing machine called the Rotoclear. The Rotoclear is powered by a 365-horsepower diesel engine and weighs 21,000 pounds. It is not self-propelled and must be pulled by a D-6 size crawler tractor or large wheeled tractor such as a John Deere 540 log skidder. The treatment width is 7½ feet and the machine can mulch to a depth of 9 inches. The machine costs $99,750 (March 1980) U.S. funds, fob Calgary.

As a rule of thumb, if material can be cut with an ax, the Rotoclear can mulch the material. When land clearing, trees up to 5 inches in diameter do not have to be removed or cut before mulching. But above 5 inches it is generally best to cut them to within 5 inches of the ground. Stumps 4 to 5 feet in diameter, if 5 inches or less in height, pose no problem. The Rotoclear machine can reduce them to a mulch. Production rates have averaged 1¼ to 1¾ acres per hour when the machine can be pulled at 1 to 2 mph.

The Rotoclear has been used to grind soap stone lime for fertilizer, grind volcanic rock for the manufacture of concrete block, recondition asphalt, and mix materials for road construction.

The machine is not designed to crush rock but if rock is encountered, it will not hurt the machine but only cause more rapid teeth wear. There are 56 teeth that wedge into pockets on the rotating drum. A set of teeth can be replaced in about 45 minutes. Generally, about 75 to 100 hours are accumulated on a set of teeth before replacement. Teeth cost $7 (U.S.) each.

Power to drive the rotor is transmitted through a Detroit Diesel Allison 575 torque converter to a Rockwell rear drive truck axle and then by dual chains to the rotor, which turns at 360 rpm.

Rotoclear machine.

Rotor of Rotoclear machine with 56 replaceable teeth.

Specifications

Designation: Madge Rotoclear

Status: Production

Cost: $99,750 (U.S.) (March 1980) fob Calgary

Manufacturer:

Can-A-Mex Mfg. Ltd.
8211 31st St. S.E.
Calgary, Alberta
Canada T2C 1H9

(403) 479-7750

Prime mover: D-6 size crawler tractor or large wheel tractor

Reduction head:

Type—Horizontal shaft
Cutters—56 teeth wedged into pockets welded on rotor

Width of cut: 7½ ft

Maximum material size: If cut to 5 in above ground, 7 ft

Work material size: 5 in

Type of drive: Torque converter

Rotational speed: 360 rpm

Drive engine: Diesel, 365 hp, GM 8V-92

Width: 9 ft 8 in

Length: 22 ft 6 in

Height: 9 ft

Weight: 21,000 lb

Ground pressure: 2.5 psi @ 6 in penetration when working

Three Machines for Mechanical Plant Control

By Boone Richardson, Director, Forest Service Equipment Development Center, San Dimas, Calif.

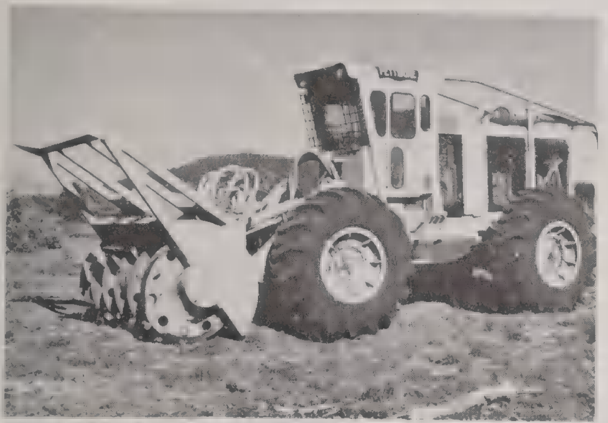
Brush Harvester. An articulated, track-mounted brush harvester has been developed by Jim O'Dair of NFI, Inc., and Fred Smith of Georgia Pacific to harvest wood fiber for energy from Southern pine forests. The prototype can harvest boiler fuel and strip thin to release pine. Brush and standing stems 5 inches dbh (diameter breast height) are felled, fed into a chipper, and conveyed into a self-dumping hopper. Estimated purchase price for the complete unit is $160,000; operating cost is expected to be $45 per hour. The machine is powered by a 430-horsepower engine. Total length of the brush harvester is 28 feet 6 inches; cutter head width is 8 feet; and total weight empty is 42,000 pounds. Hopper capacity is 3 tons. The prototype is undergoing field tests near Crossett, Ark.

Track-mounted brush harvester.

Residue Shredder. The 600-horsepower, four-wheel rubber-tired machine is being used for site preparation work in the Mississippi Delta. NFI, Inc., developed the machine for Crown Zellerbach Corp. The shredder fells any standing stems, shreds downed stems, tops, branches, brush, stumps, and incorporates the biomass into the top layer of soils on sites following harvest of cottonwoods. The cutterhead is a rotating drum with 88 replaceable carbide teeth that rotates at 850-900 rpm. Estimated purchase price is $175,000, and operating cost was $52.25 per hour before recent fuel price increases. The machine has operated for 3 years north of Vicksburg, Miss., near Fitler.

NFI, Inc.'s 600-horsepower residue shredder.

Pettibone Hydro-Slasher PM 800. The Pettibone machine treated Utah juniper during a demonstration on the Kaibab National Forest near Williams, Ariz. The machine shredded and broke up juniper clumps 8 feet high with 6-inch stems. It is powered by a 262-horsepower engine. The slasher is 28 feet long, 9 feet wide, and weighs 35,410 pounds. The cutterhead has a horizontal shaft with 10 free swinging hammers. The head rotates at 975 rpm. The demonstration was with a production prototype and information on purchase price and delivery time is available from Pettibone Michigan Corp., P.O. Box 368, Baraga, Mich. 49908.



Pettibone Hydro-Slasher PM 800.

New Tractor Shredder Combination

By Calvin Kuska, Roscoe Brown Corp., Lenox, Iowa

The Roscoe Brown Corp. has recently combined the Brown Bear Cub four-wheel-drive tractor to the Royer Woodsman shredder for clearing and reclaiming land by shredding. The production rate of this combination is 1½ to 4 acres per day and can shred material up to 6 inches in diameter.

New combination of Brown Bear Cub four-wheel-drive tractor and Royer Woodsman shredder. Both are hydrostatically driven.

Chemical Plant Control

Ray Dalen, *Chairman*

(Reported by Dick Hallman)

Herbicides have been aerially applied on rangelands for many years, using a wide variety of equipment and materials. Even with today's greater concern for environmental safety, it appears such spraying will continue, with more effort directed at the evaluation of the various spray systems to determine their advantages and disadvantages

On many projects, aerial application is the most practical technique. But the principles of aerial application of herbicides under wildland conditions are not always fully understood by field personnel. Spray drift off the target area, which may result in reduced effectiveness and environmental damage on adjacent areas, is a prime concern. A great deal of research and development is directed toward finding practical ways to reduce drift. However, much of the information is not in a form useful and available to field people.

To help solve this problem, a contract was awarded to Norman B. Akesson, University of California at Davis, to prepare a handbook to help field people who plan and supervise aerial herbicide application projects. The handbook covers project operations and safety, application equipment, meteorology, principles of drift control, spray drop spectrum selection, spray pattern assessment, and related topics. A draft is now undergoing thorough review. Publication is planned for FY 1981.

Structural Range Improvements

Ron Haag, *Chairman*

(Reported by Bob Hamner, Forest Service, Dickinson, N.Dak.)

The Structural Improvements Workgroup was a new workgroup last year and spent most of 1979 organizing and identifying projects needing research and development.

Individuals who have agreed to serve on the Structural Range Improvements Workgroup are: Ron Haag, chairman, Forest Service, Missoula, Mont.; Walt Rumsey, Soil Conservation Service, Lincoln, Nebr.; Bill Erickson, Bureau of Indian Affairs, Flagstaff, Ariz.; Ethan Freeman, Bureau of Land Management, Vale, Oreg.; Dennis Childs, Windrock International, Morrilton, Ark.; Bob Knudson, Forest Service Equipment Development Center, Missoula, Mont.

The first order of business was to identify needed work projects. Each workgroup member was assigned the responsibility of identifying projects from his agency or in the case of Dennis, the agriculture community at large. The response was tremendous, with 26 projects identified. These projects were further evaluated and three were selected for recommendation to the VREW steering committee for approval and funding. These were:

- A national structural improvement handbook
- Use of solar energy to power livestock water systems
- Use of electrical fencing as an alternative to more traditional rangeland fencing methods

A project, ED&T 0314, Rangeland Water Systems Improvements, was approved and funded with assignment to the Forest Service Equipment Development Center, San Dimas.

During the course of the VREW meeting, the Structural Range Improvement Workgroup sponsored two additional reports. Jan Smolders presented a paper on Gaucho® barbed wire, and Chuck McGlothin presented a paper on the use of solar energy in the development of range water systems.

Special Reports

American Council for Reclamation Research VREW Liaison Report

Willis Vogel, *Forest Service, Berea, Ky.*
(Presented by Arlo Dalrymple,
Office of Surface Mining, Washington, D.C.)

The American Council for Reclamation Research was formed in 1978. It is an outgrowth of the organization formerly called the Council for Surface Mining and Reclamation Research in Appalachia. The American Council for Reclamation Research (ACRR) lists five objectives:

1. Promote, assist, and support research relating to land reclamation.

2. Encourage communication between researchers, regulatory agencies, landowners, and the surface mining industry so that research is coordinated and addresses relevant problems.

3. Provide a list of expertise to those agencies, organizations, or others who seek assistance in developing and performing specific research, or demonstration projects.

4. Promote and support educational programs relating to land disturbances associated with mineral extraction.

5. Assume responsibility for development and sponsorship of accreditation standards for the certification of educational institutions engaged in reclamation technology programs.

ACRR is affiliated with the Canadian Land Reclamation Association for the sponsorship of *Reclamation Review*, an international journal published quarterly by arrangement with Pergamon Press.

Membership in ACRR is open to those who are contributing to land reclamation research through their work in scientific, practical, and administrative fields; who support council policies; and who remit their annual dues.

Annual membership dues are $10 for regular members and $5 for students. An additional $15 provides members with a subscription to *Reclamation Review*. For more information on membership, write or call:

William T. Plass, Executive Secretary
21 Grandview Dr.
Princeton, W. Va. 24740
(304) 425-8332

Cost of *Reclamation Review* without membership in an affiliate group is $77 per year and can be ordered from Pergamon Press, Maxwell House, Fairview Park, Elmsford, N.Y. 10523; (914) 592-7700.

The ACRR meets twice a year. Meetings include the presentation and discussion of technical papers, an appropriate field trip, and a business session. Meetings have been held in different locations in the East, usually near areas where reclamation research or demonstrations are being done on surface-mined land.

At the fall 1979 meeting, at the University of Alabama, the council considered establishing the position of executive secretary. The past-president, William Plass, is acting as executive secretary until action is final. The president of ACRR is now Dr. Richard Barnhisel, Agronomy Department, University of Kentucky.

The council has been helping to develop an accreditation program and curriculum for associate degrees in reclamation technology. As yet it has been unable to establish such a program. The need for accreditation is recognized, but the responsibility involved in administering such a program is causing hesitation among the membership.

The ACRR is cooperating with the West Virginia Academy of Sciences in the editing, purchase, and sale of proceedings from a symposium of mined land reclamation held in April 1979.

"The Land Reclamation Report," which was published by the Harvest Publishing Co., Cleveland, Ohio, and to which members of ACRR contributed, was discontinued in October 1979.

The council assisted McGraw-Hill Publishers in developing two special sessions on revegetation at the October 25, 1979, Coal Conference and Expo V program in Louisville, Ky.

The 1980 spring meeting of ACRR will be at Oglebay Park, Wheeling, W.Va., on May 6 and 7. A field trip will focus on acid neutralization systems.

ACRR is interested in exploring the possibility of cooperative equipment testing with VREW. Undoubtedly, some types of equipment could be used for reclamation in both western and eastern situations. The ACRR Council would like to know whether VREW is interested in any cooperative effort. If so, ACRR would like to explore current testing programs to determine those that may be of interest to both groups. ACRR also needs to know if funding would be available for cooperative tests.

Canadian Land Reclamation Association Annual Meeting

Farnum M. Burbank, *Forest Service, Washington, D.C.*

On August 13-15, 1979, I attended the Canadian Land Reclamation Association (CLRA) annual meeting in Regina, Saskatchewan, Canada. This is the second of these meetings that I have attended representing VREW, and I am still of the strong opinion that this is an excellent cooperative relationship. The two organizations have much in common and good technology exchange between them can reduce redundancy in efforts. Several U.S. people were on the program this year presenting significant information on developments in reclamation work that can be quite beneficial to both countries.

Chairman Ted Russell has on file the copy of the proceedings I received. It is available to anyone; please feel free to request it.

One of the things that makes this meeting quite valuable is the emphasis on biological and geological aspects of reclamation, as contrasted to our VREW emphasis on equipment and material manipulation. Much of the work discussed was primarily detailed research, covering such topics as water movement, migration of noxious materials, sizing particles, selective placement of materials, water table control, etc. Certainly, the best approach to material manipulation must consider these other factors, otherwise, there could be gross failures in reclamation, and there are a number of these. So, a combination of these sessions is of great value, especially for people like myself, an engineer.

I also attended the CLRA business meeting at the end of the session. They are still in the throes of trying to get the organization fully underway. They now have 276 members, and are having some financial difficulties. They will probably have to raise their dues to $30 next year. I was invited to say a few words on behalf of VREW. After that, it was suggested that a joint meeting of VREW and CLRA might have some value. I agreed, but pointed out that it might be 2 or 3 years in the future. Our Government foreign travel restrictions would make a general joint session quite difficult.

The 1980 meeting will be in August again, probably somewhere in the maritime area, i.e., New Brunswick, Nova Scotia, Quebec area.

I have already requested authorization to attend. I hope that it will be granted again. For those who might be in a position to go, I highly recommend it. They are a fine, enthusiastic group of people.

I am still enthusiastic about someone from VREW attending CLRA meetings and them being represented at our meeting. I appreciate the opportunity to act in this capacity.

4th Annual Meeting
Canadian Land Reclamation Association
August 13-15, 1979

Schedule of Events

Sunday, August 12, 1979		Faculty Club University of Regina
7:00-8:30 pm	Registration	
8:00-10:00 pm	City of Regina Reception	
Monday, August 13, 1979		Education Auditorium University of Regina
8:00-8:30 am	Registration	
8:30-9:00 am	Welcome to Delegates	
	Dr. C. W. Blackford, Dean Faculty of Graduate Studies & Research University of Regina	
	Mr. Phillip D. Lulman, Acting President Canadian Land Reclamation Association	
9:00-12:00 noon	Plenary Session A—The Saskatchewan Story	
	Problems encountered in land reclamation by the agriculture, potash, coal and pipeline industries in Saskatchewan will be discussed.	
Chairperson:	Dr. M. Evelyn Jonescu, Director Canadian Plains Research Center University of Regina	
Panel Members:	Mr. W. Earl Johnson (formerly with Saskatchewan Agriculture)	
	Dr. E. H. Halstead Saskatchewan Institute of Pedology University of Saskatchewan	
Coffee Break		
	Mr. Gary Douglas, Reclamation Engineer Saskatchewan Power Corporation	
	Dr. E. de Jong, Professor Dept. of Soil Science University of Saskatchewan	
12:00-1:30 pm	Lunch Break	
1:30-5:00 pm	Symposium	
	Management of Toxic/Noxious Materials in Drastically Disturbed Landscapes - Material Handling and Selective Placement.	
Chairperson:	Dr. S. R. Moran Alberta Research Council	
Papers:	Hydrogeochemical Concepts Applied to Mined Land in the Fort Union Region. C. D. Palmer and J. A. Cherry	

	How Effective is the Deep Placement of Acid Spoil Materials? H. B. Pionke and A. S. Rogowski
	Characterization and Selective Placement of Inhibitory Material in Montana. V. J. Dollhopf
Coffee Break	
	Effects of Surface Manipulation on Percolation, Infiltration, and Groundwater Quality. I. B. Jensen and W. M. Schafer
	Effects of Topsoil Thickness Placed on Spoilbanks on Wheat and Corn Yields in North Dakota. M. W. Pole, Armand Bauer, Leroy Zimmerman, and S. W. Melsted
	Analysis of Water Accumulation and Storage in Strip-mined Soils of Western North Dakota. H. O. Carvallo, G. W. Gee, and A. Bauer
Tuesday, August 14, 1979	
8:00 am-6:00 pm	Tour
	Tour of Saskatchewan Power Corporation Boundary Dam generating plant and reclamation activities in strip-mined areas.
	One tour bus will load at the Regina Inn and one at the Landmark Inn at 7:30 am. They will both meet at the south entrance of the College West building at 8:00 am.
8:00 pm	Banquet Faculty Club University of Regina
Wednesday, August 15, 1979	Education Auditorium University of Regina
9:00-12:00 noon	Symposium
	Reclamation of Drastically Disturbed Landscapes by Surface Treatment and Management Practices.
Chairperson:	Mr. Phillip D. Lulman, Acting President Canadian Land Reclamation Association
Papers:	Building Soils Using Athabasca Oil Sands Tailings and Soil Amendments. A. W. Fedkenheuer
	The Capacity of Reclamation Plant Communities to Supply Their Own Nutrients: When Does Maintenance Fertilization Become Necessary? P. F. Ziemkiewicz
	The Use of Native Species in Mine Tailings Revegetation. A. L. Kuga and T. C. Hutchison
Coffee Break	
	Potential of Soil Amendments as Sources of Native Plants for Revegetation of Athabasca Oil Sands Tailings. A. W. Fedkenheuer and H. M. Heacock

	Reclaiming Surface Mines with Black Locust Fuel Plantations. S. B. Carpenter and R. A. Eigel
	The Regional Municipality of Sudbury's Land Reclamation Program: A Preliminary Report on a Major Cooperative Undertaking. Wm. Lautenbach and Keith Winterhalder
12:00-1:30 pm	Lunch Break
1:30-3:30 pm	Plenary Session B—Reclamation Legislation
	Problems encountered by industry, researchers, and government departments and agencies in dealing with land reclamation legislation.
Chairperson:	Dr. J. Stan Rowe, Professor Dept. of Plant Ecology University of Saskatchewan
Panel Members:	Mr. Douglas Harrington, Director Land Conservation & Reclamation Division Alberta Environment
	Dr. Richard L. Hodder, Research Associate Montana State University Montana Agriculture Research Station
	Mr. T. G. Davy, Executive Assistant to the President The Coal Association of Canada
Coffee Break	
3:30 pm	CLRA Annual Business Meeting

Forest Service Equipment Development Center Activities

Representatives from the Forest Service Equipment Development Centers at San Dimas, Calif., and Missoula, Mont., presented slide programs on current activities of interest not reported elsewhere during the workshop. Dan McKenzie presented the San Dimas program, Dick Hallman the Missoula program.

San Dimas Equipment Development Center

The San Dimas Equipment Development Center (SDEDC) is located in San Dimas, Calif., which is east of the greater Los Angeles area. About 50 people are employed at the Center, including 10 to 12 engineers and about the same number of other professionals. Center personnel are working on about 60 projects. A few of interest to workshop participants are covered here.

Qualification Test of Fire Equipment. The Center conducts qualification tests on fire equipment so that it may be placed on a Qualified Products List (QPL) for procurement by the Forest Service and other Federal agencies. Items are qualified in accordance with specifications that usually have been prepared by the Equipment Development Centers. Items include: fire pumps, fire hoses, nozzles, fire fittings, and spark arresters.

The manufacturer pays a fee for test on all items requiring qualification. The fee is charged for actual costs of qualification tests. Fees for some items such as fire pumper units are substantial, running in the $3,400 range in FY 1980.

Low-Cost Sheaths for Handtools. Firefighting handtools must have sharp edges to be effective. But when not in use, these cutting edges must be covered to prevent injury. The cost of leather and metal shields has increased considerably, prompting a search for less expensive protective sheaths. From a development effort carried out by SDEDC, the General Services Administration (GSA) has procured 70,000 plastic sheaths for the pulaski at $1.50 each. Metal sheaths cost about three times more, and leather sheaths about twice as much. Also being developed are low-cost plastic sheaths for the double-bitted ax, brush hook, and shovel. Plans are being made to develop a sheath for the McLeod tool.

Modular Air-Borne Firefighting System. The Modular Air-Borne Firefighting System (MAFFS) was developed to convert the military C-130 aircraft into an aerial tanker that can carry 3,000 gallons of fire retardant and lay a fire retardant line up to ¼ mile long. Eight of these MAFFS units are available with a 24-hour notice to supplement the air attack fleet of the Forest Service and other Federal agencies.

Anchor Program for Cable Logging Systems. Finding reliable stumps to safely anchor cable systems has become a serious problem as logging moves to more marginal sites. The Center has been investigating this problem and is developing suitable substitute anchors. Work also includes developing an Early Warning Anchor Failure Detection System. Several types of substitute anchors are now under investigation. Plate-picket type anchors are the most promising.

Grapple Skidder for Moderate Slope Slash Removal. Three types of grapple attachments were tested in partially cut stands on the Sierra National Forest in California:

- A loader grapple rake manufactured by Young Corp., attached to a Case 1150 crawler loader.
- A dozer fitted with a custom designed top clamp carried by an International TD-7 crawler tractor.
- A Case 1150 crawler tractor with a backhoe attachment carrying a grapple.

Results indicated that a loader equipped with a grapple rake can construct denser, higher, and cleaner piles than a dozer clamp rake combination or brush rake. The backhoe equipped grapple did not appear to be economical or practical for use in partially cut stands to collect and pile residue.

Hill Climbing Machine. The Center is planning to field evaluate a unique hill climbing backhoe/grapple that walks like a five-legged spider. This unit will be evaluated for its capability on steep slopes such as collecting and handling slash, installing substitute anchors, digging ditches, and other resource management activities.

Onsite Chipper for Slash Treatment. In this project the Center is planning a unit that can possibly be moved on steep slopes by its own power winches or the hill climbing backhoe for the purpose of reducing slash to chips.

Field Chipper Conveyor. The Center is investigating ways of conveying chipped residues from their location on steep slopes to a landing, which may be as far as 2,000 feet from the chipping operation. Several methods appear promising. The first is a portable overhead stretch cable carrying small gondolas; the second is an air tube in which high velocity air carries the chips to the landing.

Intermittent Containerized and Bareroot Tree Planter. The Center is investigating and developing concepts for an intermittent tree planter capable of planting both containerized and bareroot stock. This planter may eliminate the need for extensive site preparation on some sites.

Solar-Powered Vault Toilet Venting System. Solar-powered fans are being used to vent odors from vault toilet buildings. A system was developed and successfully tested at campgrounds in California and Utah by the San Dimas Center.

On a clear, sunny day, when the solar panel received maximum sunlight, it was not uncommon in the California campgrounds for the system to aspirate up to 750 fpm through a 6-inch-diameter stack. This is equivalent to an exchange every few minutes of all the air in the vault.

Funding for installation of 240 vault toilet venting systems on National Forest Recreation Areas is being supplied by a Department of Energy program.

Missoula Equipment Development Center

MEDC serves the nine Forest Service Regions and cooperating Federal and State agencies. The Missoula Center makes available to these groups information, concepts, equipment, and ideas to better manage the millions of acres of public land.

This mission of wide ranging problem solving in resource management demands varied skills. Foresters and engineers, draftsmen and illustrators, writers and photographers, equipment specialists and technicians all work as project team members to accomplish goals. MEDC occupies buildings at Fort Missoula, a military reservation a few miles southwest of Missoula, Mont. Located there are the offices housing most of the 55-member staff.

Slide Descriptions

1. The Missoula Equipment Development Center is located in western Montana.

2. By some standards, our facilities are not modern.

3. But it's the staff that's important. Because we have experts in many different fields we've done work in . . .

4. Fire Detection.

5. Safety.

6. Transportation.

7. Wildlife.

8. And even law enforcement.

9. Now to move to some of our more recent projects.

10. The Center recently worked on the redesign of an aerial ignition system that is now commercially available and known as the Helitorch. The device features a 55-gallon drum that is mounted on an aluminum frame. The fuel passes from the barrel through an electronic ignition system located at the other end of the frame.

11. With the introduction of a gel fuel, the helicopter is able to fly higher and faster than with liquid fuels and still achieve good fuel placement.

12. The Helitorch was widely used last year throughout the West for prescribed burning of forest residue.

13. It was also used on the Angeles National Forest in California to maintain fuel breaks. The Helitorch promises to become an important tool to help land managers use fire more effectively.

14. In some cases the logging residue is suitable for use as fire wood.

15. But because of access problems the average woodcutter cannot reach the material.

16. To help make logging residue available for forest users in situations like this, the Center has been working with fuels management personnel to develop lightweight cable systems like the Clearwater Yarder.

17. Yarding the debris to roadsides helps prepare the site for planting.

18. And makes the wood available for wood cutters.

19. Equipment like the Clearwater Yarder will find increased use as fuelwood becomes more important as a source of energy.

20. Rock Rakes have been used for many years for light maintenance. Their effectiveness has been somewhat limited, however, because of the problem of mounting the rake on fleet vehicles.

21. Center engineers have designed a mount that enables the driver to apply downward pressure on the rake.

22. And also angle the rake from controls in the cab.

23. The rake will undergo final testing this summer on several National Forests.

24. Laser guidance systems are being used to guide earth moving and other types of construction and agricultural equipment.

25. We are currently evaluating them for guiding nursery equipment.

26. A receiver unit is attached to the tractor.

27. And the operator keeps the machine in line by watching the arrows in his display box.

28. Our tests so far indicate that we can operate tractors within 1-inch tolerance in 1,000 feet. This can mean more uniformity in the nurserybed and savings for the nursery manager.

Papers

Dryland Sodding — A Summary

Jane Bunin, *Science Application, Inc., Boulder, Colo.;*
Joann T. Hackos, *Colorado School of Mines, Golden, Colo.;*
Michal Harthill, *Water and Power Resources Service, Denver, Colo.*

The Northern Great Plains Coal Province (NGPCP) will likely experience a great increase in surface coal mining in the coming decades. In the semiarid Northern Great Plains (NGP), the reestablishment of disturbed native vegetation is often hampered by unpredictable climatic conditions, slow soil development, and the lack of viable seed sources. Despite such difficulties, much of the strip-mined land has shown initial successful revegetation by seeding. However, certain sites show unsatisfactory results with seeding or have serious erosion problems. The proposed technique, dryland sodding (DLS), may prove a useful reclamation method for such problem sites.

We define sodding as a reclamation method in which a unit of soil and its associated vegetation is removed intact from an area about to be mined, transported to a mined area readied for revegetation, and redeposited intact on graded and suitably prepared spoil. The method is further labeled dryland sodding because no irrigation is required past the initial week of establishment. The primary advantages of this procedure are to:

- Minimize wind and water erosion by facilitating a more rapid, self-sustaining revegetation than seeding provides.
- Preserve the original soil, root system, and soil microbiota intact.
- Provide a source of healthy plant material native to the mine site.

These advantages are each related to the larger concept of succession, or the relatively orderly and predictable replacement of one biological community by another that occurs on a site that has been disturbed or on a bare site. A succession study reveals that DLS can provide many advantages over other mined-land reclamation methods. Sodding will start the recovery process at a more advanced successional stage than seeding, and will help that recovery progress more rapidly. It provides vegetation compatible with surrounding plant communities. We expect, however, that great variability will occur in the recovery rates after sodding, depending on the biotic, environmental, and management conditions at the site.

As the three primary advantages and the succession considerations indicate and as we shall show in the following report, biological and environmental factors favor the use of DLS. However, we would like to present a caveat from the start. Current economic and logistical considerations may make DLS far more expensive than seeding in terms of direct initial cost. On the other hand, if indirect or delayed costs are taken into account, DLS may still prove advantageous. Costs that may be lower with DLS can be derived from the following:

- Faster attainment of diverse, productive, or stable vegetation, as required by law, and therefore, earlier release of bond.
- Improved water quality due to decreased soil erosion.
- Improved air quality due to decreased wind erosion of soil.
- Earlier use for grazing.
- Less long-term maintenance, and improved esthetics.

Environmental and Biological Factors

As we indicated, the climate, soils, and kinds of vegetation in the NGP all affect the success of a reclamation technique. Therefore, we will review briefly these environmental and biological features as they exist in that region. Our goal will be to develop from our understanding of climate, soils, and plants, a set of DLS guidelines for the mine operator.

Climate

In the semiarid Western States, plant-available moisture is most frequently the limiting factor for successful revegetation of disturbed areas. Recurring cycles of drought, when little growing season moisture is available, are the most significant climatic features of the NGPCP. A site may vary from humid to arid from

one year to the next; the variance is unpredictable. The total average annual precipitation is between 12 and 16 inches. The precipitation maximum, occurring in May and June in most of the region, coincides with the period of maximum grassland growth. Later in the summer, drought brings the growing season to a close. The mid-summer months, late June, July, and August, can have high temperatures, which, when combined with the ordinary low humidity and high winds, cause high evaporation rates, resulting in severe soil and plant desiccation. In sum, the usual low humidity, variable precipitation, and large diurnal and annual temperature ranges are key features of the NGP continental climatic regime.

Because germinating seeds and seedlings have little resistance to drought that can occur unpredictably in a given year and does occur during periods of low precipitation, inadequate precipitation can easily cause a seed-based reclamation plan to fail. In contrast, established plants, even if they are cut in a sod piece, are far more drought resistant. As a result, DLS can be well suited to reclaim sites where seeding has not or is not expected to be successful because of drought-related problems.

Because of summer drought, late June through August are poor times to sod. In contrast, autumn and early spring have low rates of moisture loss and precede periods of relatively good moisture supply, making them potentially good times to sod. Other factors, however, must also be considered. For instance, in autumn, frozen ground and the ensuing winter dormancy of the plants, can hinder successful establishment of the sod. Or in spring, mud may prohibit using the equipment needed to cut, move, and lay the sod.

What we have described so far have been conditions affecting the NGP as a whole that must be recognized to evaluate the potential of DLS. In addition, microclimatic variations, variations that occur at different microsites within a mine depending on aspect, percent slope, or wind exposure, will affect plant-available moisture. DLS will have the best chance of success if the piece of vegetation is relocated to a microsite with wind and slope exposures, steepness, and slope position similar to those existing at the original location of the sod.

Soils

Soil composition varies widely as a result of the diverse clay, sand, and silt sediments found on the NGP. Soils in the western two-thirds of the NGPCP tend to be poorly developed, whereas the eastern portion has relatively fertile, well-developed soils. There are also some clayey soils, badlands, and sandy soils that will pose edaphic problems for the DLS, but these would also have vegetation too sparse for sodding.

Most areas present no special soil reclamation problems, although some mines will have to segregate toxic overburden. These toxic spoils require similar handling whether seeding or sodding is used.

Only one soil, found in Montana, could pose a problem for DLS that would not be immediately obvious in the poor condition of the vegetation. Certain rocky (lithic) soils (Orthents) might have a vegetative cover appropriate for a sod, but contain too many rocks. Rocks can cause the soil to break apart when an equipment operator tries to pick up an intact strip of earth.

The advantages of maintaining the plants in their original soil environment are substantial. The integrity of the topsoil in a sod piece is important. The intact soil layer of the turf contributes to the ability of DLS to provide a rapid and reliable plant cover at a disturbed site. In contrast to this intact soil layer in sod, mixed topsoil (as commonly used in surface-mine reclamation) has lost the soil-binding root mats and surficial organic matter that decrease erodibility, and contains diluted and buried seeds, roots, and organic matter. The organic matter present in the soil improves its chemical, physical, and biological properties. These advantageous properties are lost when a topsoil is mixed. Further, if the mixed topsoils are stockpiled, they lose the microorganisms and plant-available nutrients necessary for the health of the original plant community.

Vegetation

Four vegetation types found in the NGP are candidates for successful DLS. In our description of them below, we have identified the soils where they occur, the region in the NGP where they are most common, and the principal plant species present.

Grassland-sagebrush occurs on silty clay loam soils in southeastern Montana and northeastern Wyoming and contains mid and short grasses, with scatter sagebrush.
Short-grass prairie occupies dry prairies on shallow soils in southeastern Montana and northeastern Wyoming. Dominant species are blue grama grass, western wheatgrass, and various needlegrasses.
Mid-short-grass prairie occupies rolling prairies on loam to clay loam soils in eastern Montana and is characterized by western wheatgrass, needle-and-thread grass, and blue grama grass.
Mid-grass prairie occurs on loamy soils in extreme eastern Montana, southwestern North Dakota, and northwestern South Dakota. Principal species are needlegrasses, wheatgrasses, and blue stem grasses.

These four types rate relatively high in terms of two vegetation characteristics necessary for DLS success:

- Sufficiently high vegetative cover, and
- Enough plants with shallow, dense roots or horizontal stems in the surface soil.

Both characteristics are required to maintain sod-strip integrity during transportation. If the sod strips break apart, the plants' roots will dry out. This will either kill the plants or reduce their chances of survival. About half of the common species of the four candidate vegetation types are good soil binders. These include the frequently dominant blue grama grass, western wheatgrass, and dryland sedges.

Survival and success of the relocated sod depends on many plant features. A plant species' season of maximum growth, its natural vegetative spread, its rate of growth, drought resistance, and tolerance to grazing all influence how well it will withstand sodding and thrive.

Interactions of Factors

Environmental characteristics affecting the survival and vigor of sod are diverse. When they are taken into consideration, the importance of matching sod donor and recipient microsites is again emphasized. Soil moisture is critical. It is influenced indirectly by grazing and directly by precipitation, temperature, wind and soil physical properties. Soil physical properties, in turn, also influence soil aeration, temperature, and plant nutrient availability. Grazing at moderate levels can stimulate plant root networks, but at high levels can deplete root reserves and reduce plant vigor and productivity. Therefore, grazing must be carefully controlled. Similarly, fertilizer use must be closely monitored. Fertilizers can affect plant species composition and dry matter production.

Dryland Sodding Guidelines

From our analysis of the biological characteristics of the four types of vegetation listed above, and taking into account climate, soil, and other environmental factors, we have concluded that dryland sodding is feasible as a reclamation method in the NGPCP. However, sodding may prove far more expensive than seeding because of higher labor and equipment requirements. Therefore, we recommend that it be considered the method of choice only on critical or problem sites where: (1) rapid revegetation is crucial; (2) high erosion potential exists; (3) seeding has been or is expected to be unsuccessful or unsatisfactory; or (4) appropriate seeds are not available.

After the mine operator has made a study of the site to be reclaimed, he should consider DLS feasible only if the following are true:

- Existing plant cover is perennial vegetation in satisfactory range condition and is desirable for the post-mining land use.
- Surface soil-binding plants exist on the mine sites in sufficient quantity to allow a useful amount of intact sod to be transported even short distances.
- The soil where the sod-forming plants are growing is sufficiently consolidated and free from rocks to be cut into pieces and moved to a new location.
- Sufficient water is available either from natural or supplied sources to water the sod before cutting and to irrigate the newly laid sod once or twice. The soil or material receiving the sod should not be watered before the sod is laid or undesirable compaction will occur.
- The overburden of topsoil receiving the sod has been appropriately prepared to provide a nontoxic and relatively favorable medium to which the sod can bind.
- Sufficient moisture is available for the roots to bind to the substrate and for the plants to become established.

Once these criteria are met, the mine operator should consider the following suggestions, which are the result of experimental research on dryland sodding:

Timing—spring sodding seems best, although fall sodding can also be successful.
Depth of cut—cutting depths for native grasses are 2 inches for blue grama, 2 to 4 inches for buffalo grass, 6 inches for inland salt grass, and 2 to 3 inches for western wheatgrass. Blue grama has proven especially successful.
Irrigation—watering before cutting and soon after relocation markedly increases sod survival.
Placement—laying the sod in depressions to prevent erosion and desiccation of edges and rolling the sod to insure good root contact are recommended.

We recommend the following guidelines to the mine operator who decides to carry out a DLS program:

Planning—plan all phases, especially timing, equipment, and personnel allocations, before beginning operations.
Training personnel—establish a training program for equipment operators and other personnel conducting the operation.
Equipment preparation—obtain or modify existing equipment to meet DLS requirements. (The Forest Service Missoula Equipment Development Center (MEDC) is working on a dryland sodder.)
Spoils preparation—separate and detoxify overburden, grade and contour, and construct moisture traps before cutting sod.
Topsoil placement and preparation—replace any reserved topsoil available in the same manner as for seeding. Create depressions for the sod strips.
Sod cutting—consider pruning the plants just before sod cutting to stimulate their growth. Cut sod strips

with razor sharp blades between 2 and 6 inches deep depending on the plant species present. Determine the most efficient piece dimensions based on equipment configurations and the requirements for maintaining sod integrity.
Sod handling and transport—avoid timing that will cause the sod to dry out severely and avoid actions that will cause the sod to break.
Sod placement—decide upon a placement pattern for the strips or pads that will resist desiccation and erosion, facilitate moisture collection, and provide the basis for good vegetative cover.
Sod maintenance—eliminate or control grazing and keep root-eating rodents under control.
Evaluation—review establishment and succession of the sod for a number of years.

These guidelines are starting points for a dryland sodding program. However, crucial questions on equipment and transportation matters still need to be answered. More work is needed by experts in equipment design and mine operations. When such questions are answered, good cost estimates can be made to determine more precisely the feasibility of dryland sodding.

If you have comments on this work, please send them to Jane Bunin, Science Applications, Inc., 2760 29th St., No. 209, Boulder, Colo., 80301. The Bureau of Mines, Environmental Activities Group, Denver, Colo., is supporting this work and will be producing a paper on dryland sodding.

New Prescribed Burning/Backfiring Tool Tested in Brush

Denny Bungarz, *Fire Management Officer,*
Mendocino National Forest, Willows, Calif.

Recently a new firefighting and prescribed burning tool was tested in brush on the Mendocino National Forest.

Gelled-fuel helitorch enables pilots to drop fire with greater accuracy and speed.

The helitorch, a backfiring device slung under a Bell 206B helicopter was tested by U.S. Forest Service personnel on the Grindstone Chapparal Management Area on March 21 to 24, 1979.

The helitorch originated in Canada. Western Helicopter Services, Inc., of Newberg, Oreg., improved the design and added the gelled-fuel concept, with the assistance of the Forest Service Missoula Equipment Development Center. Simplex Manufacturing Co., Portland, Oreg., is making the helitorch for Western Helicopters. Improvements in the original design include mixing a fuel thickener with gasoline, which forms a flammable substance the consistency of unset gelatin.

The helitorch consists of an aluminum frame that holds a 55-gallon barrel, a small electric motor that drives a small positive displacement gear pump, and an ignition device. The pump and ignition source are activated by a switch controlled by the pilot. The pump is capable of discharging the 55 gallons of gelled gas in 4 minutes. The helicopter pilot controls the flow and ignition of the gelled fuel. The new gel enables pilots to drop fire with greater accuracy from higher altitudes and faster speeds, increasing safety and efficiency. Fire on the ground can be obtained from a height of 200 feet at an airspeed of 40 mph. This produces burning gelled-gasoline globules the size of golf balls that burn 8 to 10 minutes. Drop heights of 150 feet and airspeeds of 30 mph produce baseball-size lumps that burn on the ground 12 to 17 minutes. The optimum speed and elevation during testing was 60 mph at 100 to 150 feet above the brush.

The experiment on the Mendocino was the first time the helitorch was tried in brush. After initial testing at the nearby Willows airport, the helicopter and helitorch were moved to a large road turnout on the Grindstone Project that became a helibase for the next 3 days. The Grindstone Project is a chapparal management-demonstration area of 165 square miles where brush is managed for wildlife, watershed, range, and fire management objectives.

A large group of Forest Service, Bureau of Land Management, California Department of Fish and Game, and California Department of Forestry land managers gathered to see how the helitorch would burn brush. Weather readings taken at the site, however, indicated that the chamise type brush probably would not burn as the humidity was over 70 percent, the 10-hour fuel stick was 28, and a rain storm was fast approaching. It was decided to try anyway to show the firing pattern, to develop operational procedures, and not to disappoint the gathered group.

To everyone's surprise, the helitorch successfully ignited a 20-acre patch of brush in about 10 minutes. The brush burned completely inside the area outlined by the flaming gel and went out, without benefit of firelines, natural breaks, or younger age brush on the mid-slope brush field.

The Firing Boss decided to try another patch of brush below the first. Within another 8 to 10 minutes and with 55 gallons of Alumagel (a fuel thickener) and gasoline another 20 acres of brush was burned. By this time, the rain storm was in the area, and the burning was over for the day.

During the next 2 days, with more favorable weather, about 1,000 acres of brush were burned. The largest burn was 180 acres, ignited by two loads from the helitorch—a total of 15 minutes flying time. The other patches of burned brush were from 10 to 35 acres on south and southeast facing slopes. They were without control lines. The fires all went out on their own as the humidity went up to over 70 percent, starting at about 4 pm each day.

One particularly impressive job the helitorch performed was to build a fuel break by burning along a cat line running about 3,000 feet down a ridge. The copter pilot placed two loads down the ridge in a zig-zag pattern, and after the smoke cleared, went back with another load and finished burning islands of brush that remained.

Cost-per-acre to use this tool was estimated at $5. This cost is probably high due to the experimental nature of this demonstration. Helitorch operation guidelines were developed during this time, and many more people than were needed were on the site. In addition, the Firing Bosses were trying north-facing slopes and areas of sparse fuels. Also, many runs were made near the helibase for demonstration and for the news media.

This tool has definite applications for prescribed burning. It will allow land managers to burn when the weather is wetter than with conventional methods. Also, areas difficult to reach or unsafe to reach with manpower, are accessible to the helitorch. This tool should allow land managers to burn when smoke dispersal is good and should increase the acres-per-day of burning.

Its application for backfiring also is excellent. Accessibility is almost unlimited. If a land manager needs a great amount of heat to cause a wildland backfire, the helitorch should do the job.

Video tapes of the operation, operating procedures, and a prescribed burn plan are available from the Fire Management Officer, Mendocino National Forest, Willows, Calif. 95988.

Rare Plant Propagation

Phillip L. Dittberner, *Plant Ecologist,*
Fish and Wildlife Service, Fort Collins, Colo.

There has been much interest in recent years in endangered or rare plant species. Much of the interest has been stimulated by the Endangered Species Act of 1973, Public Law 93-205. The attendees of this workshop will probably be primarily interested in two sections of this Endangered Species Act. Section 2 deals with the identification and protection of habitat, including critical habitat where threatened and endangered species are found or depend on for some part of their life cycle. Section 7 addresses the review and consultation procedures necessary to protect the species listed or nominated for listing under the Endangered Species Act and their habitats.

The act defines "endangered species" as any species that is in danger of extinction throughout all or a significant portion of its range. "Threatened species" is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Much of the discussion this morning will be applicable to rare plants as well as to threatened and endangered plants covered by Public Law 93-205. The main emphasis of the act is directed toward restricting Federal agency activities that might result in the destruction of endangered or threatened species and their habitats on public lands.

The regulations promulgated to enforce the act encourage the commercial activity of buying and selling of threatened and endangered plants and the growing of cultivated threatened and endangered plants. This encouragement is directed toward three groups of activity related to threatened and endangered plants: (1) the propagation and growing of plants that have been removed from the wild and are grown for commercial puposes; (2) the trade and growing of seeds and plant materials of cultivated plants; and (3) the loan or exchange of herbarium materials. The trade and propagation encouragement does not apply to commerical activities that involve taking wild plants from their native habitats.

Numerous authors have written papers related to threatened and endangered plants. Several of these papers identify management strategies that could or should be used in the management of resources or habitats where threatened and endangered plants are found (e.g., Zeedyk et al. 1978; Simmons et al. 1976). Suggested management activities include: (1) inventory compilation of threatened and endangered species and their habitats; (2) refuge establishment for protection of populations of threatened and endangered plants and their habitats; (3) special environmental practices that may be implemented or used in managing threatened and endangered plants and their habitats; and (4) identification of techniques for the propagation or growing and production of threatened and endangered species under cultivated conditions.

These strategies are fairly self explanatory. Inventory compilation includes the cataloging of habitats where the various species are found, population sizes, and the biological and ecological characteristics of the species and their populations. A complete set of guidelines for status reports for each species has been drafted (Henifer et al. 1979) and is currently being used by the Office of Endangered Species, U.S. Fish and Wildlife Service. The status report is a description of each species, including information on taxonomy, biology, distribution, ecology, propagation, and other characteristics.

Refuge establishment is the setting aside of areas where a rare, threatened, or endangered species, or group of species, are found in their native habitats. Refuge establishment is most appropriate for endangered species, especially those restricted to isolated populations on fragile sites; to remnant populations; and to climax community species. These refuges should be managed with the objectives and techniques necessary to not only maintain the populations found there, but also in some cases to encourage their expansion into adjacent areas.

Special environmental practices include those forest, wildlife, and range management techniques that are designed for, and that will protect a threatened or endangered plant, its habitat, and the plant community to which it belongs. These practices may include maintenance of critical seral stages of plant communities, maintenance of specific soil conditions related to species adaptation in the area, and manipulation of other plant species to control competition.

Artificial propagation is applicable when extinction appears imminent, when a natural population is threatened despite protection and management, or where species have commercial value. Artificial propagation includes the development of propagation and growing techniques necessary to produce threatened and endangered plants in controlled conditions. This might involve determining new propagation techniques, stratification or scarification techniques, nutrient or water requirements, and breeding techniques.

The latter two areas, special environmental practices and artificial propagation, may require specific new equipment development or modification to implement research results.

There are three major areas of information and research needs for rare, threatened or endangered species. These are developing: (1) complete understanding and descriptions of life histories, (2) complete descriptions of habitat requirements, and (3) complete population dynamics pictures for each species.

Two terms are relative to management and propagation of endangered and threatened plants or other rare plants that we need to define very carefully. These are "reintroductions" and "introductions." "Reintroductions," as used here, is replacing a plant in a habitat where it once existed but, for some reason, no longer occurs there. "Introduction" is placing a plant in a habitat that it was not previously known to occur. Introduction is often thought of as moving plants to new habitats, thus expanding their range of occurrence. Whereas this is true, we must be very careful in introducing threatened and endangered plants in new habitats. Often there may be very subtle and poorly understood habitat conditions that would not allow the successful introduction of a species in a new area. Reintroducing plants to an area will oftentimes be fairly successful unless some site conditions have changed since the time they previously were occupants of the site. In general, reintroductions are more likely to be successful than are introductions.

The state-of-the-art for propagation, growing, and management of rare, threatened, and endangered plant species is very immature. Few people have done research on these topics. Some examples of this past research are discussed below.

Farmer and others have worked with several species. These were *Heterotheca ruthii* (Farmer 1977), Cumberland rosemary (*Conradina verticillata*), (Farmer and Lockley 1978), and turkey beard (*Xerophyllum asphodeloides*), (Farmer 1978). Each of the species required different cultural techniques: *Heterotheca ruthii* could be grown using standard greenhouse and nursery techniques; *Cumberland rosemary* required cloning and vegetation propagation; and turkey beard required 6 months stratification before the seeds would germinate and could be grown using standard greenhouse and nursery techniques.

The Upper Colorado Environmental Plant Center in Meeker, Colo., has done some work with threatened and endangered or rare species (U.S. Soil Conservation Service 1979). Different cultural techniques were required by the different species studies, including yellow oil shale columbine (*Aquilegia barnabyi*), dragon milkvetch (*Astragalus lutosus*), catseye (*Cryptantha stricta*), wild buckwheat (*Eriogonium ephedroides*), beard-tongue (*Penstemon yampaensis*), and Utah fescue (*Festuca dasyclada*). Research results proved that yellow oil shale columbine required 90 days of stratification for good germination; dragon milkvetch, catseye, and bear-tongue were not stratified and had very poor germination; wild buckwheat was not stratified and no seeds germinated; Utah fescue was not stratified and had fair germination.

The question arises as to why threatened, endangered, or rare plants should be studied or propagated; we tend to think very negatively about working with rare plants. There are at least three reasons for this attitude: (1) legal and regulatory interpretations about how these plants can be dealt with; (2) the unknown life histories for many of these plants; and (3) the unknown cultural techniques needed for successful plant propagation.

By carefully examining the management strategies and expanding our research programs relating to threatened and endangered or rare plant species, we can increase our resource management options in many areas. We may also find that there are special equipment needs for germination, planting and maintenance of some of these populations as well as for some of the other management options that may prove useful.

The Vegetative Rehabilitation and Equipment Workshop (VREW) has a history of expanding interest and efforts into new management areas that are biologically and legally important and for which there are special equipment needs. I am sure that as we work with more rare, threatened, and endangered species we will find that there are special equipment needs that the equipment centers and others interested in equipment development and fabrication will be interested in pursuing.

References

Farmer, R. E. Jr.
1977. Seed propagation of *Heterotheca ruthii*. Castanea 42 : 146-149.

__________.
1978. Preliminary observations on the germination of turkey beard. *Newsletter* North Carolina Wild Flower Preservation Society, Inc. Spring 1978, pp. 26-31.

Farmer, R. E., Jr., and G. C. Lockley.
1978. Vegetative propagation of cumberland rosemary. The Plant Propagator 24 : 14.

Henifin, Mary Sue, Larry E. Morse, James L. Reveal, Bruce MacBryde, and Jane I. Lawyer.
1979. Guidelines for the preparation of status reports on rare or endangered plant species. Memo. USDI, Fish and Wildlife Service, pp. 31.

Simmons, J. B., R. I. Beyer, P. E. Brandhem, G. L. Lucas, and V. T. H. Parry, eds.
1976. Conservation of threatened plants. NATO Conference Series I : Ecology, Vol. I, Plenum Press, New York, pp. 336.

USDA, Soil Conservation Service.
1979. Upper Colorado Environmental Plant Center SCS-EPA Semi-Annual Progress Report (January-June 1979). Memo. USDA, Soil Conservation Service, Upper Colorado Environmental Plant Center, pp. 5.

Zeedyk, W. D., R. E. Farmer Jr., B. MacBryde, and G. S. Baker.
1978. Endangered plant species and wildlife management, J. For. 76 : 31-36.

What's New in Seed

Art Armbrust, *Sharp Bros. Seed Co., Healy, Kans.*

Primary sources of new varieties and germplasm:

- Public Plant Breeders
  —Science and Education Administration
  —Agricultural Experiment Stations

- Private Plant Breeders
  —Private Seed Companies
  —Private Research Groups
  —Individuals

- Plant Material Centers

- Materials harvested in wild and placed under controlled *multiplication*

- Plant Introductions

Primary private breeding efforts have been in crops of economic importance; high-volume crops and items that lend themselves to merchandising.

Primary areas of private breeding efforts:

- Garden and Flower Seed

- Turf Seed

- Hybrid Corn and Hybrid Sorghum—Hybrid Sunflower

- Soybeans

- Cereal Crops—Wheat

- Alfalfa—Red Clover

- Forage Grasses
  —Bromegrass
  —Orchardgrass
  —Reed Canarygrass

It is apparent that little, if any, effort is involved with native seeds in private breeding programs. However, a number of native seed growers and processors are involved in the total seed industry.

Private efforts have been enhanced because of the Plant Variety Protection Act. Public efforts were concentrated in many of the same areas as private breeders for years. Now they have been shifted from practical breeding to more basic work with many of the crops listed in areas of private breeding effort.

Some areas of public practical breeding effort:

- Soybeans

- Cereals—wheat (oats, barley, rye, triticale)

- Legumes—alfalfa and others

- Pasture and forage grasses

Below is a list of some of the public breeding and research efforts with grasses, listed by States, species, and general area of effort.

State	*Species*	*Type of Effort*
Colorado	Western Wheatgrass	Breeding for adaptability to revegetative work
Canada	Bromegrass Crested Wheatgrass Reed Canarygrass Intermediate Wheatgrass Orchardgrass	Breeding
Canada	Wheatgrasses—Fescues Bluegrasses and other varieties	Breeding work
	Meadow Bromegrass	Testing and breeding studies Studying crosses made with smooth brome

State	*Species*	*Type of Effort*
Georgia	Annuals Bahia	Breeding research
Florida	Switchgrass Guineagrass Ryegrass and others	Breeding research
Iowa	Reed Canarygrass Bromegrass Orchardgrass Tall Fescue	Breeding
University of Kentucky	Tall Fescue	Ryegrasses and tall fescues Materials Ken Hy
Maryland, Beltsville	Forage Grasses Turf Grasses	Breeding
Minnesota	Reed Canarygrass	Digestibility
	Reed Canarygrass Orchardgrass Tall Fescue	Breeding
Missouri	Orchardgrass Tall Fescue	Breeding
Montana	Intermediate Wheatgrass Wheatgrasses Crested Wheatgrass	Use of cytoplasmic Sterility for Hybrids
	Quackgrass and Fairway Crested Wheatgrass	Evaluation of a rhizomatous material
Nebraska	Switchgrass	Increased digestibility
New Mexico	Western Wheatgrass Tall Wheatgrass Indian Ricegrass Black Grama Grass	Breeding work
North Carolina	Lowland Switchgrass	Breeding and selection
North Dakota	Russian Wildrye Intermediate Wheatgrass Orchardgrass Crested Wheatgrass Western Wheatgrass	Breeding
Oregon	Tall Fescue Other Fescues	Breeding
Pennsylvania	Orchardgrass Smooth Bromegrass Fescue Buffalograss	Breeding
Texas	Weeping Lovegrass Dallis Grass	Digestibility Breeding

State	Species	Type of Effort
Utah — Doug Dewey, Perry Plummer	Wheatgrasses Smooth Bromegrass Orchardgrass Wildrye Fescues Reed Canary	Studying plant introductions for adaptability and use as germplasm
	Numerous other grasses especially Wheatgrasses	Breeding studies of interspecific hybrids
Wisconsin	Smooth Bromegrass	Breeding for improved types to be used with Alfalfas

This list indicates that there is some effort with the native species and some introduced species that are used in the arid and semiarid areas of the United States. Many of these materials are a necessary ingredient in current reclamation and reseeding efforts. Many of the efforts dealing with native species are rather recent. Actually, there were few native seeds used before World War II and only with the advent of the Soil Bank Program of the midfifties was there any volume of native grasses harvested and used. Most seeds used during this period were harvested from native stands wherever they could be found. During the early sixties the multiplication of improved cultivars of native species took hold and today, 20 years later, the improved materials constitute a major portion of the native and introduced grass seed available for reclamation. The majority of improved cultivars of native species and quite a few cultivars of introduced grass and legume species used for revegetation have been originated by the Soil Conservation Service plant materials centers.

About 16,000 plant collections are being evaluated at any one time at the 22 plant centers located across the United States. More than 50 percent of these are native plant collections.

Since 1943, SCS has released about 200 varieties of conservation plants to commercial seed growers and nurserymen. Over the years, some of these releases have been replaced by superior varieties. In 1977, about 140 SCS-released plants were in use in conservation programs. Commercial production of SCS released plant materials in 1977 was about 9 million pounds of seed, 9 million woody plants, and 2 million bushels of sprigs. The retail value to seed growers and nurserymen was more than $22 million. This amount of seed and plants is about the equivalent of that required to treat more than 1.7 million acres of land.

At the end of this paper is a list of the 32 new varieties of conservation plants cooperatively released through SCS. Also listed are proposed releases by SCS plant materials centers in the years 1980-85.

That's the good news. Now the bad news.

At present, SCS is looking into the possibility of transferring some or all of the plant materials program activities to non-Federal control. The study will consider fund-sharing, management, and staffing arrangements.

Here is a summary of the responses to this proposal by SCS State Conservationist Plant Materials Center Advisory Committees:

- Improved plant materials and techniques for their effective use are vital to the success of SCS-administered programs and that the PMC concept is essential to effectively meet these needs.

- There are no viable options to transfer PMC's without full Federal funding at current or increased levels on a continuing basis.

- SCS technical assistance to the non-Federal cooperators would be required if the program continues to contribute to multistate and regional problem solving.

- If full Federal funding and SCS professional technical assistance can be assured, there are options for transferring most PMC's to non-Federal control.

- The committees strongly support continuation of PMC's as an SCS function. Transfer will result in a mixture of non-Federal cooperators and create problems in coordination.

- Some States, not having a PMC, may receive less help. There is a danger of priorities shifting to those within the State where the center is located and perhaps to the specific priorities of the non-Federal cooperator.

- State Conservationist PMC Advisory Committees would be needed to help assure that the work of the center is consistent with needs and priorities of SCS-administered programs.

- If Federal funding and technical assistance are necessary to continue an effective coordinated pro-

gram there appears to be no advantages to transferring PMC's to non-Federal control.

It seems quite foolish to transfer and fracture an ongoing and successful program when there is an ever-increasing need for the plant materials that this group works with. Currently, plant materials centers are working on these high priority needs:

- Improving water quality by stabilizing critical high-yielding sediment sources such as surface-mined lands, highway slopes, recreation sites, and urban and industrial development areas.

- Protecting coastal, river, streambank, pond, and lake water lines from erosion by wave action.

- Improving windbreaks and shelterbelts for the reduction of airborne sediment, control of snow drifting, and the prevention of crop damage from wind erosion.

- Controlling critical erosion areas such as coastal sand dunes.

- Converting land not suited for intensive crop production to permanent cover.

- Developing pasture and rangeland plant species that extend the livestock grazing season, give better soil protection, and produce superior forage quality and yield.

- Improving wildlife food and cover species and special plants for esthetic and recreational purposes.

- Stabilizing land disposal area.

- Developing fire-retarding plant cover to replace brush on mountain foot slopes to reduce the possibility of fires that threaten life and property or result in serious sediment sources.

The Federal Government has increased requirements for plant materials through the Surface Mining Act; various highway seeding requirements; requirements for seeding rights-of-way for roadways, pipelines, gravel pits, etc. We could have additional needs because of the recent Range Resources Act. Yet, at this time of almost certain increased needs for plant materials, the Federal Government is cutting one of our most important potential sources of improved plant materials. It just doesn't make sense to seek economies in government by fracturing an ongoing, badly needed program that is fundamental to so many other activities.

Certainly, I will admit a selfish interest involved here. We at Sharp Bros. Seed Co. depend a great deal on the plant materials centers for foundation seed of many items we produce. However, this is true of all growers, processors, and handlers of the materials many people need. We know they're needed because many of these materials are required to be seeded by both Federal and State regulations. Most of these same materials are being used by Federal and State agencies to meet their own seeding requirements.

What are the PMC's costing the taxpayer?

Budget of the PMC's

Fiscal Year 1978	$2,884,000
Fiscal Year 1979	$2,693,000

Conduct of the Study to Transfer Plant Materials Activities

- Intent to study published in the *Federal Register* on June 16, 1979.

- Public hearings to be conducted by the State Conservationist after February 1, 1980.

- Public hearings to be concluded by April 15, 1980, and reports submitted to National Office by May 1, 1980.

- By June 1, 1980, formulate alternative proposals taking into account public reaction.

- By July 1, 1980, publish alternative proposal(s) in the *Federal Register* and solicit comments (deadline August 31, 1980). Send copy of *Federal Register* notice to those who participated in earlier meetings, requesting their comments. (National Office)

- September 1-30, 1980—Consider comments and revise the proposal, if necessary. Respond in writing to comments. Prepare recommendations for USDA. (National Office)

- On or before September 30, 1980, make recommendation to USDA and publish recommendations in the *Federal Register*. Also send copy of *Federal Register* notice to those who participated in meetings or wrote letters. (National Office)

What Can We Do?

We hope that all users and producers will make their concerns known. You should let your Congressman and the Secretary of Agriculture, Bob Bergland, and the Administrator of SCS, Norman Berg, know your concerns. Copies of letters from concerned individuals and groups might also be sent to Senator Thomas F. Eagleton, and Congressman Jamie L. Whitten, Chairman of the Senate and House Appropriations Subcommittees on Agriculture and Related Agencies, respectively.

If you need additional information about the possible transfer of the plant materials centers to non-Federal control, you may contact Dr. Thomas N. Shiflet

or Mr. Robert S. MacLauchlan, Ecological Sciences and Technology Division, Soil Conservation Service, P.O. Box 2890, Washington, D.C., 20013, telephone (202) 447-2587, -2588, or -5667.

Perhaps I have strayed from the topic "What's New In Seeds?," but I feel strongly that the PMC's should continue to be federally funded and administered rather than be "scattered to the winds."

New Cooperative SCS Plant Releases, Since January 1, 1978

1. 'Alamo' switchgrass - Texas (Knox City PMC)
2. 'Aztec' Maximilian sunflower - Texas (Knox City PMC)
3. 'Prairie Gold' Maximilian sunflower - Kansas and Nebraska (Manhattan PMC)
4. 'Sunglow' Greyhead prairieconeflower - Kansas and Nebraska (Manhattan PMC)
5. 'Bonita' soaptree yucca - New Mexico (Los Lunas PMC)
6. 'Barranco' desertwillow - New Mexico (Los Lunas PMC)
7. 'Florigraze' perennial forage peanut - Florida (Brooksville PMC)
8. 'Redalta' limpograss - Florida (Brooksville PMC)
9. 'Greenalta' limpograss - Florida (Brooksville PMC)
10. 'Bigalta' limpograss - Florida (Brooksville PMC)
11. 'Appalow' sericea lespedeza - Kentucky (Quicksand PMC)
12. 'King-Red' Russian-olive - New Mexico (Los Lunas PMC)
13. 'Jemez' New Mexico Forestiera - New Mexico (Los Lunas PMC)
14. 'Montane' mountainmahogany - New Mexico (Los Lunas PMC)
15. 'Flame' Amur maple - Missouri (Elsberry PMC)
16. 'Nezpar' Indian ricegrass - Idaho (Aberdeen PMC)
17. 'Roselow' Sargent crabapple - Michigan (Rose Lake PMC)
18. 'Shoreline' common reed - Texas (Knox City PMC)

Through December 1978

New Cooperative SCS Plant Releases—Since January 1, 1979

1.	'Cimarron'	little bluestem	Manhattan, Kans.
2.	'Elsberry'	autumn-olive	Elsberry, Mo.
3.	'Cling-Red'	Amur honeysuckle	Elsberry, Mo.
4.	'Ganada'	yellow bluestem	Los Lunas, N. Mex.
5.	'Viva'	galleta	Los Lunas, N. Mex.
6.	'Cardan'	green ash	Bismarck, N. Dak.
7.	'Cochise'	Atherstone lovegrass	Tucson, Ariz.
8.	'Imperial'	Carolina poplar	Rose Lake, Mich.
9.	'Big horn'	skunkbush sumac	Los Lunas, N. Mex.
10.	'Magnar'	basin wildrye	Aberdeen, Idaho
11.	'Casa'	quailbush	Lockeford, Calif.
12.	'Marana'	fourwing saltbush	Lockeford, Calif.
13.	'Dorado'	bladderpod	Lockeford, Calif.
14.	'Canbar'	canby bluegrass	Pullman, Wash.

Proposed Plant Released By SCS Plant Materials Centers

1980 through 1985

Aberdeen, Idaho		
Linum Lewisii Lewis flax	Appar	1980
Agropyron spicatum bluebunch wheatgrass	P-739	1981
Sanguisorba minor small burnet	PI-297951	1981
Agropyron cristatum crested wheatgrass	Ab-447	1983
Eurotia lanata winterfat	—	1984
Atriplex canescens fourwing saltbush	—	1985
Americus, Ga.		
Lespedeza thunbergii Shrub lespedeza	Amquail	1980
Indigofera pseudotinctoria false anil indigo	—	1982
Lespedeza cuneata sericea lespedeza	AM-312	1983
Spartina patens marshhay cordgrass	—	1984
Big Flats, N.Y.		
Secale cereale rye	—	1981
Andropogon gerardi big bluestem	NY-1145	1981-82
Berberis koreana Korean barberry	NY-4773	1981-82
Lathyrus latifolius everlasting pea	NY-5136	1980-81
Rudbeckia hirta blackeye susan	—	1982
Salix purpurea gracilis slender willow	NY-2936	1982
Salix purpurea nana dwarf willow	NY-2931	1982
Chrysanthemum leucanthemum ox-eye daisy	—	1983
Trifolium medium zig zag clover	—	1983
Aster novae-angliae New England aster	—	1984
Cornus stolonifera red stem dogwood	—	1983-84
Hesperis matronalis dames rocket	—	1984
Malva moschata mush mallow	—	1984
Agrostis alba red top	—	1985

Bismarck, N. Dak.		
Pyrus ussuriensis Harbin pear	ND-14	1980
Syringa amurensis japonica Japanese tree lilac	ND-686	1980
Celtis occidentalis hackberry	Mandan 12003	1980
Lonicera tatarica tatarian honeysuckle	ND-313	1980
Prunus americana American plum	—	1981
Fraxinus pennsylvanica green ash	SD-13	1981
Andropogon gerardi big bluestem	SD-27	1982
Agropyron smithii western wheatgrass	ND-456	1982
Panicum virgatum switchgrass	SD-149	1982
Shepherdia argentea buffaloberry	—	1983
Bridger, Mont.		
Elymus trichodes beardless wildrye	P-15594	1980
Petalostemum candidum white prairieclover	NDL-56	1982
Elymus cinereus basin wildrye	P-15590	—
Oryzopsis hymenoides Indian ricegrass	P-15597	—
Atriplex nuttalii nutall saltbush	P-15658	—
Brooksville, Fla.		
Aeschynomene americana American jointvetch	—	1982
Arachis glabrata perennial peanut	Arbrook	1983
Cape May, N. J.		
Spartina patens marshhay cordgrass	—	1980-81
Panicum virgatum switchgrass	NJ-50	1980-82
Elaeagnus umbellata autumn olive	NJ-927	1981
Spartina alterniflora smooth cordgrass	—	1981-82
Ammophila arenaria European beachgrass or *Panicum amarum* bitter panicgrass	—	1981-82
Coffeeville, Miss.		
Castanea mollissima chinese chestnut	—	1980
Paspalum nicorae brunswickgrass	—	1982
Calamagrostis pseudophragmites chee reedgrass	—	1984
Corvallis, Oreg.		
Lupinus albicaulis sickle-keel lupine	Hederma	1980
Salix spp. willow	—	1985
Agropyron spp. wheatgrass	—	1985
Elymus glaucus blue wildrye	—	—
Elsberry, Mo.		
Andropogon gerardi big bluestem	M-2-10407	1983
Sorghastrum nutans Indiangrass	M-1-5734	1983
Hoolehua, Hawaii		
Crotolaria juncea sunhemp	HA-6	1980
Paspalum hieronymii hieronymus paspalum	HA-3131	1980
Paspalum vaginatum seashore paspalum	HA-190	1980
Dolichos hosei sarawak bean	HA-3518	—
Knox City, Tex.		
Engelmannia pinnatifida engelmann-daisy	T-874	1980
Sorghastrum nutans Indiangrass	T-802	1980
Simsia calva bush sunflower	T-856	1980
Dichanthium spp. old world bluestem	T-587	1980
Sporobolus airoides alkali sacaton	T-1733	1980
Bouteloua gracilis blue grama	T-1221	1980
Anisacanthus wrightii wright anisacanth	T-1230	1980
Cassia fascicultata prairie senna	T-1985	1981
Bouteloua curtipendula sideoats grama	T-470	1981
Menodora longiflora showy menodora	T-862	1983
Strophostyles helveola trailing wildbean	T-1879	1983

Lockeford, Calif.		
Phalaris arundinacea reed canarygrass	Cana	1980
Erogonum umbellatum sulfur buckwheat	PI-421013	1980-81
Salvia sonomensis creeping sage	PL-28370	1981
Ceanothus cuneatus buckbrush	PL-9959	1982
Dactylis glomerata orchardgrass	Berber	—
Los Lunas, N. Mex.		
Bouteloua gracilis blue grama	NM-118	1980
Bouteloua curtipendula sideoats grama	NM-28	1980
Eurotia lanata winterfat	NM-333	1981
Panicum plenum false switchgrass	NM-265	1982
Atriplex canescens fourwing saltbush	—	1983
Manhattan, Kans.		
Heliopsis helianthoides ox-eye	—	1980
Rhus trilobata skunkbush sumac	—	1980
Echinacea angustifolia black sampson coneflower	—	1982
Silphium laciniatum compassplant	—	1982
Liatris punctata liatris	K-1327	1983
Bouteloua gracilis blue grama	(2 acc'ns)	1983
Penstemon cobaea penstemon	—	1984
Meeker, Colo.		
Oenothera hookeri hooker primrose	—	1980
Fallugia paradoxa apache plume	—	1980
Bromus marginatus mountain brome	—	1981
Festuca thurberi thurber fescue	—	1982
Pullman, Wash.		
Agropyron spicatum bluebunch wheatgrass	P-6409	1981
Quicksand, Ky.		
Panicum virgatum switchgrass	KY-1625	1980-82
Salix X cottetii cottet willow	KY-663	1981
Trifolium ambiguum Kura clover	KY-1282	1982
Alnus serrulata hazel alder	—	1983
Rose Lake, Mich.		
Alnus glutinosa black alder	MI-823	1980
Cornus amomum silky dogwood	MI-765	1980
Elaeagnus umbellata autumn olive	MI-777	1980
Lonicera bella albida white bush honeysuckle	—	1980
Tucson, Ariz.		
Bothriochloa ischaemum yellow bluestem	P-15626	1980
Panicum antidotale blue panic	P-15630	1980
Leptochloa dubia green sprangletop	P-14254	1981
Menodora scabra rough menodora	P-17773	1982
Atriplex Lentiformis Quailbush	PI-330671	1983
Bothriochloa barbinodis cane bluestem	PI-228576	—
Eragrostis intermedia intermediate lovegrass	A-19189	—
Muhlenbergia wrightii spike muhly	A-8604	—
Penstemon palmeri palmer penstemon	—	—
Cassia corymbosa senna	—	—

New Forage Plants for Rangeland

Douglas R. Dewey, *Research Geneticist, Science and Education Administration – Agricultural Research, Logan, Utah*

During the past 5 years, a five-scientist USDA-SEA-AR range-forage improvement team has been assembled at Logan, Utah. The team includes a plant cytogeneticist (D. R. Dewey), a plant physiologist (D. A. Johnson), two plant breeders (K. H. Asay and M. D. Rumbaugh), and a range scientist (F. B. Gomm). The mission of the research team is, "To provide a broad spectrum of improved forage grasses, legumes, and forbs for upgrading rangeland of the Intermountain Region for conservation, reclamation, recreation, and production purposes." This research unit is the only one of its kind west of the Rockies, and its services are available to State and Federal agencies as well as to the private sector.

Specific objectives of the various team members include: (Dewey) to collect forage germplasm from worldwide sources, to describe its reproductive and cytogenetic characteristics, and to synthesize new species through wide hybridization; (Johnson) to develop techniques for screening plants for tolerance to drought, cold, and salinity and to determine the physiological basis of stress tolerance; (Asay) to develop superior varieties of range grasses and to determine the causes of sterility in interspecific hybrids; (Rumbaugh) to develop superior varieties of range legumes and forbs and to determine the nitrogen-fixing characteristics of range legumes; and (Gomm) to evaluate improved plant materials arising from the breeding programs and to develop improved methods of establishing plants on range sites.

The legume-forb breeding program is emphasizing the development of dryland pasture-type alfalfas (*Medicago sativa* and *M. falcata*) that will persist in mixed plantings with grasses and shrubs on sites with 10 to 12 inches of precipitation. Other legumes that are receiving secondary emphasis are *Lupinus* spp., *Hedysarum* spp., and *Astragalus* spp.

Full-scale grass breeding programs are being conducted on crested wheatgrass (*Agropyron cristatum, A. desertorum*, and *A. sibiricum*), Russian wildrye (*Elymus junceus*), and a hybrid between quackgrass (*A. repens*) and bluebunch wheatgrass (*A. spicatum*). Exploratory breeding programs are being developed for native grasses (particularly *A. spicatum*) and other interspecific hybrids (notably *A. repens* X *A. desertorum*).

This paper focuses on two aspects of the range-forage improvement project at Logan: (1) the recent introduction and description of new range-forage germplasm from the U.S.S.R.; and (2) the development potential of new grass species arising from wide-hybridization.

New Forage Collections from the U.S.S.R.

During the summer of 1977, D. R. Dewey and A. P. Plummer explored for range forage plants in five regions of the Soviet Union: (1) Stavropol, in the foothills of the Caucasus Mountains; (2) Tselinograd, in the "New Lands" prairies of northern Kazakhstan; (3) Alma Ata, in an extension of the Tien-Shan Mountains, which separates China and the U.S.S.R.; (4) Dzhambul, in arid regions of the Moyun-Kum sand desert of southern Kazakhstan; and (5) Chimkent, in low-lying mountains of southern Kazakhstan. More than 1,000 seed collections were obtained, and they are now being grown at Logan, Utah (Dewey and Plummer 1980). Collections of special interest to plant breeders and range scientists are described below.

Grasses:

Elymus junceus: A major disappointment of the expedition was our failure to locate sizable wild populations of Russian wildrye. However, two outstanding improved strains were provided by the Kazakh Grassland Research Institute at Alma Ata. The two strains, the variety "Bozoisky" and a collection mislabeled as *Elymus paboanus*, have exceptional vigor at all stages of plant growth. They have been incorporated into the Russian wildrye breeding program at Logan and elsewhere, and they will constitute a primary germplasm source of new varieties released in the U.S. (fig. 1).

Elymus angustus: Altai wildrye is a coarse robust species as tall as Great Basin wildrye (*E. Cinereus*) but it has rhizomes. Canadian plant breeders released the variety 'Prairieland' in 1976 (Lawrence 1976) for fall-winter grazing in the prairie provinces. This variety is based on two plant introductions. The collecting expedition of 1977 and a subsequent seed exchange with the Shorthandy Research Station near Tselinograd resulted in 125 new collections, which will add to the breeding potential of this valuable winter forage (fig. 2).

Agropyron sibiricum: Sixteen collections of an extremely narrow-spiked Siberian crested wheatgrass were made in almost pure sand on the Moyun-Kum Desert. The forage characteristics and productivity are not particularly impressive at Logan; however, their adaptation to sand dunes may make these collections useful on very sandy sites.

Agropyron cristatum-desertorum: Some collections of the "crested wheatgrass complex" were made in every major collecting region, for a total of 137 collec-

tions. When grown at Logan, no particularly outstanding collections were noted, but the entire collection will materially expand the germplasm pool of crested wheatgrass available to breeders.

Figure 1.—Typical Russian wildrye (left) and a vigorous variety, "Bozoisky," (right) obtained from the U.S.S.R.

*Figure 2.—Soviet collectors observing a valuable winter forage species, Altai wildrye (*Elymus angustus*).*

Agropyron intermedium-trichophorum: The intermediate wheatgrasses are the most prevalent wheatgrasses in Central Asia, and we brought 89 collections back. Wide variation occurred in vigor and spread; some of the collections look as promising as PI 98568, the accession from which almost all intermediate wheatgrass varieties have been selected (Hanson 1972).

Legumes:

Medicago spp.: Yellow-flowered (*M. falcata*) and purple-flowered (*M. sativa*) alfalfas are both widespread in the Soviet Union, and we obtained about 25 collections of each. The most interesting collection was a rhizomatous purple-flowered alfalfa from the Chimkent region. A special effort was made to find root-proliferating alfalfas that might do well on rangeland, but none was found.

Melilotus spp.: White and yellow biennial sweetclover (*M. alba* and *M. officinalis*) grow almost everywhere in the Soviet Union. The yellow-flowered type was the most common. The one collection of *M. dentatum*, which came from Stavropol, proved to be low in coumarin and is perennial at Logan. Plant breeders may be able to transfer the perennial habit and low coumarin from *M. dentatum* to the biennial species.

Trifolium ambiguum: We probably have the world's largest collection of kura clover growing at Logan. The staff of the Stavropol Botanical Garden donated their entire collection to us, and we added our own collections to theirs. This clover was slow to establish at Logan, and it showed wide variation in rhizome development. Certain clones produced abundant seed. This is important because low seed set has been one of the factors restricting the use of kura clover.

Astragalus spp.: The genus *Astragalus* provided the most varied and intriguing species collected during the trip. Many *Astragalus* species have ornamental as well as forage value. One species, *A. alopecias*, from the Moyun-Kum Desert has soft, velvety, intricate leaves and semi-woody stems that terminate into a striking cylindrical inflorescence. This species has great possibilities as an ornamental (fig. 3). *Astragalus ponticum* is a large and coarse species that the Soviets are using as a silage plant. Some *Astragalus* species were entirely prostrate; some had strong rhizomes; and only one, *A. macropteus*, had high levels of poisonous nitro compounds (Williams 1979).

*Figure 3.—*Astragalus alopecias, *a species with forage and ornamental value.*

Synthesis of New Grass Species

More than three-fourths of the Triticeae tribe perennial grasses (*Agropyron, Elymus, Sitanion,* and *Hordeum*) are polypoid species that arose in nature by hybridization between other species, often followed by chromosome doubling (Sakamoto 1973). Plant breeders now have the capability of synthesizing new species by procedures similar to those that have been so successful in nature. The new cereal crop, Triticale, is a manmade species derived from hybrids between wheat (*Triticum aestivum*) X rye (*Secale cereale*) followed by chromosome doubling (Gustafson 1976). Forage grasses are even better adapted to wide-hybridization breeding than are the cereals.

During the past 20 years at Logan, more than 250 different hybrid combinations have been produced, and more than 50 incipient species have been synthesized from these hybrids. Most newly synthesized species are inferior to existing species, but a few seem to have sufficient promise to warrant the attention of grass breeders. Almost all of the potentially valuable new species have *Agropyron repens* in their pedigree. With the proper choice of the other parent, hybrids can be obtained that have the vegetative vigor and adaptation of *A. repens* and lack its aggressive spreading habit. Four hybrids of considerable promise are: (1) *A. repens* X *A. desertorum;* (2) *A. repens* X *A. cristatum;* (3) *A. repens* X *A. curvifolium* (a Spanish endemic); (4) and *A. repens* X *A. spicatum.*

The most outstanding hybrid species of the group is *A. repens* X *A. spicatum* (Dewey 1976), and our grass breeder, K. H. Asay, is devoting much of his time to that hybrid. The initial cross was made in 1962 (Dewey 1967), so it has taken almost 18 years to stabilize the population cytologically and to achieve good fertility. Two types of progenies are being selected from the population, one with very short or no rhizomes and one with moderate rhizomes (figs. 4,5).

The hybrid has performed well at a wide range of sites with from 9 inches to 40 inches or precipitation. However, it will probably find its greatest use under conditions where *A. intermedium* is adapted. The hybrids are leafy, palatable (at least to rabbits), and recover rapidly after cutting. Because of these traits these hybrids also may find a place in an irrigated pasture mixture with alfalfa.

*Figure 4.—Hybrids of bluebunch wheatgrass (*Agropyron spicatum*) X quackgrass (*Agropyron repens*) in the vegetative stage.*

About 100 pounds of the hybrid seed was harvested in 1979, and it has been distributed to cooperators in several States for testing. A planting from which "breeder's seed" can be harvested will be established in 1980. If success continues, a variety release could be forthcoming in 3 years.

Figure 5.—A mature plant of the bluebunch wheatgrass X quackgrass hybrid.

Literature Cited

Dewey, D. R.
1967. Synthetic hybrids of New World and Old World *Agropyrons:* III. *Agropyron repens* X tetraploid *Agropyron spicatum*. Am. J. Bot. 54:93-98.

———————.
1976. Derivation of a new forage grass from *Agropyron repens* X *Agropyron spicatum* hybrids. Crop Sci. 16:175-180.

Dewey, D.R. and A.P. Plummer.
1980. New collections of range plants from the Soviet Union. J. Range Manage. 30: (in press).

Gustafson, J. P.
1976. The evolutionary development of triticale: the wheat-rye hybrid. Evol. Biol. 9:107-135.

Hanson, A. A.
1972. Grass varieties in the United States. Agric. Handb. 170. USDA. U.S. Govt. Printing Off., Washington, D.C.

Lawrence, T.
1976. Prairieland, Altai wild ryegrass. Can. J. Plant Sci. 56:991-992.

Sakamoto, S.
1973. Patterns of phylogenetic differentiation in the tribe Triticeae. Seiken Ziho 24:11-31.

Williams, M. C.
1978. Poisonous Plant Newsletter. Second issue, pp. 6-8.

Gaucho® Barbed Wire

Jan Smolders, *Marketing Manager,*
Bekaert Steel Wire Corp., Niles, Ill.

Gaucho barbed wire has the same breaking strength (minimum 950 pounds) as conventional 12½-gage barbed wire but has twice the thicness of zinc coating for longer life. Gaucho is made from 15½ gage higher tensil strength wire achieved by the use of higher carbon steel. Reverse twist construction limits recoil.

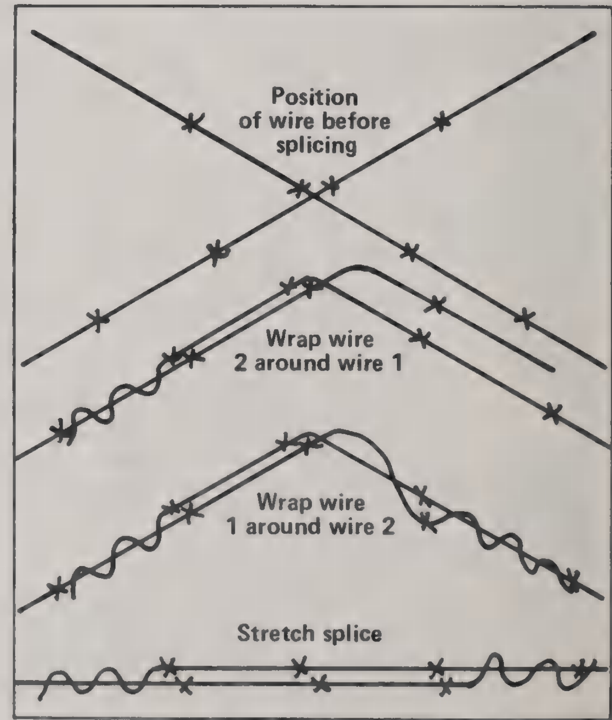
Gaucho barbed wire, a relative newcomer to the midwestern and western markets, has been available to the East and South for 20 years. It is manufactured by the Bekaert Steel Wire Corp., an affiliate of the Bekaert Group. Gaucho barbed wire is the main product of an agri-fencing plant in Van Buren, Ark., built in 1976.

Gaucho® barbed wire in protective cardboard with carrying handle.

Besides the economic advantages of savings up to 30 percent at purchase, longer fence life, and reduced number of posts required to support this lighter wire, there are some other important technical advantages to the use of this product:

- Easy fence erection because of light weight.
- Easy handling of the wire because of protective cardboard wrapper and carrying handle.
- Less sagging, hence less maintenance on the fence, because of reverse twist and less weight.
- No stretching required. Just pull tight; wire will stay up.
- Withstands temperature variations well.
- Has sharper barbs.

The only differences between conventional barbed wire and Gaucho in fence building are no stretching required and the western or telephone splice must be used (see illustration). Splices are just as strong as standard barbed wire. We have produced a booklet, "How to Build a Gaucho Barbwire Fence," which has been helpful when constructing fence using Gaucho or other barbwire.



Splicing Gaucho® barbed wire using the telephone splice.

Gaucho now commands a market share of 20 percent in the U.S., with a share of well over 50 percent in Florida, Tennessee, and Georgia. Users include King Ranch, Universal Cooperatives, Farmland Industries, and Gulf Oil. Last year 600,000 spools were sold in the U.S., and the number is growing by more than 10 percent a year.

Gaucho is sold with a specific money back guarantee. It is manufactured to meet ASTM (American Society for Testing Materials) Standard Specification for Zinc-coated (Galvanized) Steel Barbed Wire, ASTM 121-77. It is available from the General Services Administration (GSA) under NSN 5660-01-070-0469 for the 2 point type and NSN 5660-01-069-3048 for the 4 point type.

Comparing Gaucho® Barbed Wire and Standard Barbed Wire

	Gaucho barbed wire	*Most competitive barbed wire*
Gage	15½	12½
Weight Spool	41-43 lb	82-86 lb
Length	80 rods	80 rods
Strength	950 lb min	950 lb min
Steel Quality	C 1020	C 1008
Zinc Coating	.80 oz/ft^2 min	.20-.30 oz/ft^2 min
Twist	reverse	continuous
Stretching Required	no	yes
Cost	25-30% less	—
Meets ASTM A121-77	yes	usually yes
Handle for Carrying	yes	no
Protective Wrapper Around Roll	yes	no
Rolls/Pallet	48	27
Pallet & Shrinkpack for Outside Storage	yes	no
"Start This End" Tag	yes	no

A Wood Densifier

Walt Turner, *Range and Watershed Forester, California Department of Forestry, Riverside, Calif.*

Rangeland improvement in brush covered areas throughout the Western United States has been and continues to be a difficult and expensive problem. We know that by reducing the brush density we can increase site productivity for grazing animals. Countless methods have been devised to control brush, and new methods are still being developed. Methods currently used include mechanical clearing, herbicide treatment, prescribed burning, and hand clearing.

Reseeding of desirable forage species often follows in areas where they were not present before brush removal. Followup treatment either by reburning or application of herbicides is often necessary for complete control of resprouting brush.

Eventually the brush competition can be reduced to a point where a substantial forage increase can support enough of an increase in grazing that the brush control

costs can be overcome through increased revenue. This may occur within a 3- to 5-year period, depending on the success rate of the brush control program and followup management practices.

Costs of brush control may vary from $10 per acre for a one-shot prescribed burn, to several hundred dollars for a more involved program. We are continually looking for ways to reduce these costs, but brush removal is still a program with a high initial cost.

If we can look at the brush as a resource that someone would be willing to buy, then perhaps we could help offset some of the brush removal costs by selling the brush once it has been removed.

The biomass volume of the vegetation type removed in range improvement projects may vary from 10 to 40 tons per acre. The point is that we may have a usable resource available on our rangelands today that is being wasted. Instead of using our current practices that are aimed at nonrecovery of the brush types, let's look at the possibilities of harvesting this material.

First, we will need a mechanical harvester capable of cutting, chipping, and collecting the materials. Few machines are capable of doing this, but some do exist. If clean, high quality chips were harvested, we might be able to sell them for up to $70 per ton. But brush chips contain a large quantity of bark, leaf, and twig material that makes them unsuitable for the normal chip markets.

The California Department of Forestry and U.S. Forest Service, Cleveland National Forest, are currently investigating densified wood and its market potential. Densified wood is wood waste formed into cubes, briquettes, pellets, or logs under high pressures and temperatures. The product is clean, uniform, low in moisture content, and is easily marketed. Dry chips are first processed through a hammermill and stored in a hopper above the densifier. The material then passes through the densifier where it emerges in a continuous flow in briquette form. The material is readied for shipment by being bagged, stacked on pallets and wrapped. The briquettes are sold in 20-pound bags and can be used for barbequing, campfires, fireplaces, or wood burning stoves. Briquettes sold in bulk are available and are currently being used for firing boilers and producing energy. One ton of oven dry wood is equal in heating value to about two-thirds of a ton of coal, 2¾ barrels of oil, or about 16,000 cubic feet of natural gas.

The California Department of Forestry is interested in making this densification equipment or similar equipment transportable so that brush species and other wasted wood resources may be recovered and converted into a usable product. We hope to provide at least some offsetting return to the rancher interested in range improvement. A feasibility study on a transportable densifier is being made by the University of California at Davis and will be completed in June. We hope to have a unit in operation in San Diego County by January 1981.

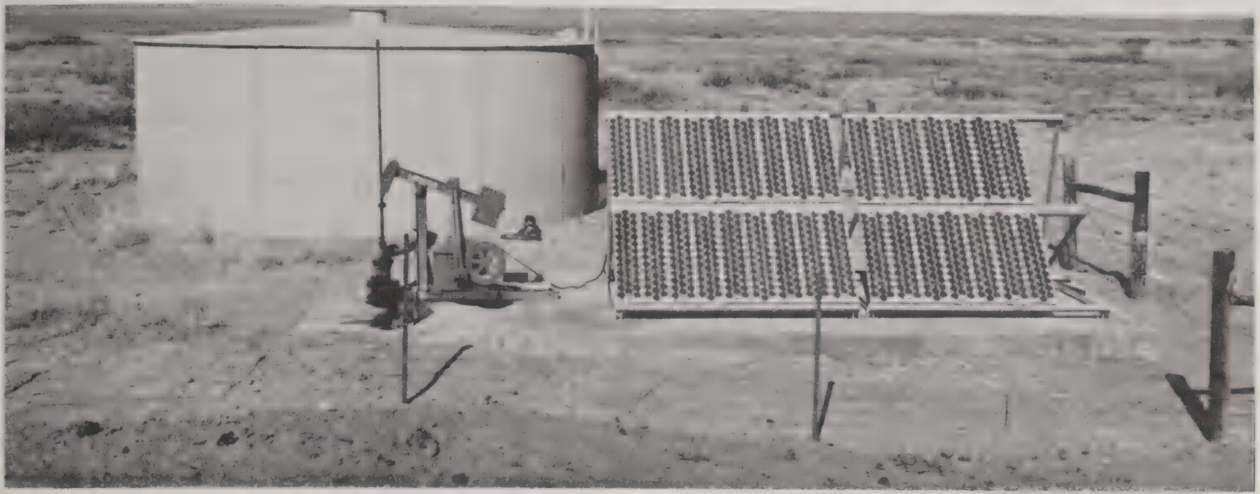
Using Solar Energy in Range Watering Systems

Charles E. McGlothlin, *Range Staff Officer, Custer National Forest, Billings, Mont.;*
Roy Lockhart, *Bureau of Indian Affairs (ret.), Albuquerque, N. Mex.*

Solar power use has increased dramatically in the past 10 years. However, this increase is primarily in the industrial complex and, to a lesser degree, private housing.

But solar power use in range water improvement projects is still in its infant stage. The Isleta Indian Reservation south of Albuquerque has a solar power project. This project was first considered in 1975 and put into operation in November 1976. It was the first solar-powered water well built in the United States for use by livestock.

This project uses thirty-six 19.2 watt ARCO modules supplied by Solar Technology International of California, now ARCO Solar Corp. The panels produce 691 watts of power. This was combined with a storage package of six 12-volt batteries, wired in series and in parallel, to produce a 36-volt system. Water was pumped from a 213-foot well, using a ½-horsepower dc motor and a standard 19-W-12 Jensen pump jack. At present, the pump runs 7 hours a day, producing 4 to 5 gallons per minute. Water is stored in a 30,000-gallon tank with float valves. Cattle drink directly from this tank. With little additional work, a gravity pipeline system could be installed from this storage tank.



Bureau of Land Management photovoltaic solar powered pump near Roswell, N.Mex. Systems pumps 2 to 3 gallons per minute from 380-foot water level with ½-horsepower dc motor.

The solar modules are set on a rectangular tilting steel frame set in a concrete foundation. The entire frame can be tilted from 36 degrees to 65 degrees, depending on the angle of the sun, so that the sun's rays strike as close to 90 degrees as possible.

Total cost for all components, except the well, was about $14,000.

A similar project has been installed near Roswell, N. Mex., by the BLM. This system is pumping 10 hours a day, producing 1,600 to 2,400 gallons a day from a 411-foot well.

There are 32 solar panels. Each contains 36 silicon disks or cells and produces 614 watts of power. Again, the power produced is stored in six 12-volt batteries that, in turn, operate a ½-horsepower, 54-volt dc electrical motor. A pump jack also was used on this project.

This solar powered well's electrical system cost about $9,963. This is about the same as a conventional windmill installation. The concrete foundation to support the solar panels, pump jack, and other standard pumping equipment have been added to the cost.

A solar powered system is similar to other livestock watering systems. It must be designed to fit the total need, including the number of livestock to be watered and gallons-per-minute of water needed.

Disadvantages

1. Pumping limited to daylight hours and battery storage.

2. Less effective on cloudy days.

3. Vandalism can be a problem with the exposed portions of this system.

4. Mechanical and electrical problems, mainly in the control system. These are now being worked on.

5. Solar panels produce dc power, so ac downhole submersible pumps cannot be used without converting to ac power. There is a loss of power in this step due to converter inefficiency. Researchers are trying to improve the efficiency of the conversion from dc to ac up to at least 85 percent.

Advantages

1. Uses cheap solar rays even on cloudy days.

2. Eliminates expensive electrical power installation costs and annual electric bills. (Annual electric use costs on one grazing association on the Custer National Forest are $12,000-$14,000.)

3. Eliminates petroleum products used on similar pump installations.

4. The location of water wells is not as dependent on wind needs or electric power.

5. The electric system, has low maintenance costs.

Other range improvements that should be considered for solar-powered energy are:

- Use of solar power on electric fences.
- Use of solar power for warming stock water on winter ranges, i.e., stock watering tanks, storage tanks, and trick tanks.
- Stock water pipeline distribution systems and downhole pumps.

Chaparral Vegetation Management Alternatives

J. L. Hickman, *Program Manager, Chaparral Vegetation Management R&D Program, Pacific Southwest Forest and Range Experiment Station, Riverside, Calif.*

In the eyes of the public, the chaparral lands of southern California are known simply as "those brushlands." A common question directed at any person associated with management of these lands is, "Is that a chaparral bush?" as the questioner indicates one of the many plant species that make up the chaparral ecosystem. Along with the lack of knowledge concerning quantity and quality of chaparral is the general concept that the stuff is worthless except to drive through and, for a fortunate few, to build large expensive homes in.

Those who work with and in the chaparral know how erroneous this concept is. Chaparral-covered lands are highly productive in several ways. First, they obviously are productive in tons of biomass. Look at any brushland area 2 to 3 weeks after a fire; green sprouts are seen. Five years after a fire, the chaparral vegetation is usually well established and rapidly growing. These lands are most important to southern California as watersheds and as such, play a major role in the lives of millions of people.

Chaparral vegetation is important as wildlife habitat, as productive rangeland, and for its esthetic value. It is also a potential source of energy, which we will discuss later.

The objective in managing chaparral lands was, in the past, and still is, primarily protection. This was more acceptable 28 years ago or 10 years ago than now for several reasons. A major reason is because an area that might have carried a 10,000-acre brush fire with no loss of structures 20 years ago may now have a very expensive home on every 4-acre lot. This means that today, we as managers must manage chaparral to realize both the production potential and to prevent catastrophic fires. This means the development of a manageable mosaic of even-aged stands of vegetation.

In general terms, managers have four treatment choices:

1. Protection—leave vegetation as it is, and prevent or suppress wildfire.

2. Change the density, species composition, and/or age class to obtain specific objectives, such as reducing fuel loading, enhancing wildlife habitat, or providing more recreation opportunities.

3. Type conversion—converting the vegetation from brush to something such as grass for range use, or citrus and other commercial crops, or maybe to golf courses or recreation areas.

4. Remove all vegetation to bare soil, such as a fire break.

All four of these types of treatment have their advantages and disadvantages. Their use will be determined by the land manager's objectives.

Tools for accomplishing these four treatments may also be placed in four groups. They are mechanical, chemical, biological, and fire.

A very brief overview of these four types of tools will have to suffice. Mechanical treatment includes using such things as disks, chain, ball and chain, brush blades, handtools, and different harvesting machines. They can usually be applied to specific areas with precise boundaries. Their effectiveness can be drastically reduced by the extremely rocky, rough terrain and steep slopes characteristic of southern California. A major disadvantage is the high cost of mechanical treatment, which will continue to increase.

Chemical treatment is effective, but is also expensive. It has produced so many environmental concerns and restraints that its use is currently minimal except in specific local situations.

Biological tools hold great promise, though their past use has been limited because of economic considerations. I mention specifically the use of goats in management of chaparral lands. We know goats can successfully maintain a fuel break in chaparral at an age and volume level suitable to the fire services. This can be expanded to cover large areas of land. We also know goats will get fat on a brushland diet if they are utilized properly.

We are currently suggesting action that we believe is the most practical and efficient means of using goats for chaparral management. Fuel breaks in chaparral have to be maintained a minimum of every 5 years to remain effective. This maintenance is accomplished by using equipment or handtools, and is prohibitively expensive. We recommend that contracts be let to operators of goat herds for maintenance of fuel breaks.

They would not be considered to be range animals that would be charged a grazing fee. They would simply be harvesting machines for maintaining fuel breaks. This could be cheaper than any other type of fuel break maintenance.

The use of prescribed fire as a management tool is controversial. It is currently recognized as the most efficient and cheapest tool for vegetative manipulation in chaparral. If used carefully, and with the available guides and expertise, many of the different functional objectives of the land manager can be attained with fire. If used carelessly and without careful planning and execution, prescribed fire can end as catastrophe.

Chaparral in southern California is a fire-dependent ecosystem. If the manager's desire is to maintain brush, as compared to the alternatives of converting to grass or removing completely, then fire must be used.

A critical factor in the use of fire will be its effect on air quality, and the constraints imposed by regulating agencies on air quality. In the chaparral management program, we believe prescribed fire can be used more than it is today. The program encourages land managers to become more familiar with the available knowledge about prescribed fire.

There is one more topic I wish to address briefly. There is now a massive movement throughout the country to conserve energy and to find new sources of energy. Much attention has been focused on chaparral as a potential energy producer.

We all know generally the amount of energy available in brush. We use a very rough figure of 8,000 Btu's per pound of brush. Multiply this by 15 tons per acre and 8 million acres and you have an impressive figure. Be careful of that figure. The technology is already available to produce energy from brush and other organic material. The equipment to harvest brush on the terrain associated with chaparral is not available. There is currently no brush harvesting equipment that will effectively operate on a slope greater than 20 percent, and this eliminates roughly 90 percent of the chaparral lands in southern California. Much of the remaining 10 percent is very rough, with numerous boulders and ravines. Another factor is that chaparral vegetation is fire-dependent, and to harvest it instead of burning it will probably result in a loss of this type of vegetation after two harvests. Also, will the energy produced by harvested chaparral be greater than the energy used in the harvesting and transportation process?

Mine Reclamation Costs and Systems

Michael J. Cwik, *President,*
Intermountain Resources, Ltd., Spokane, Wash.

Research on stabilizing critically disturbed areas has been conducted for decades by institutions, government agencies, and private groups in the United States. This research has been given particular impetus in the seventies with accelerated efforts in fuel and nonfuel mineral resource exploration in mining, and the enactment of environmental legislation and resulting regulations intended to minimize environmental degradation. Accelerated mineral production concurrent with enactment of environmental statutes and regulations has placed the miner in the position of having to be environmentally accountable for mineral exploitation. As a result, the mining industry is asking two basic questions:

- "What can be done to rehabilitate the surface of my mine in a way that will be consistent with environmental regulations promulgated by jurisdictional authorities?"
- "How much will this reclamation cost?"

There are answers to the first question. Current available research has resulted in a warehouse of data on surface stabilization. The careful review and interpretation of this data can support experienced judgment on recommended and defensible methods of landscape rehabilitation. The answer to the second question is more elusive because of variability in:

- Site conditions at mines throughout the United States
- Options that can be selected for post-mining land uses
- Mining activities that differ with types of characteristics of ore bodies and mine design

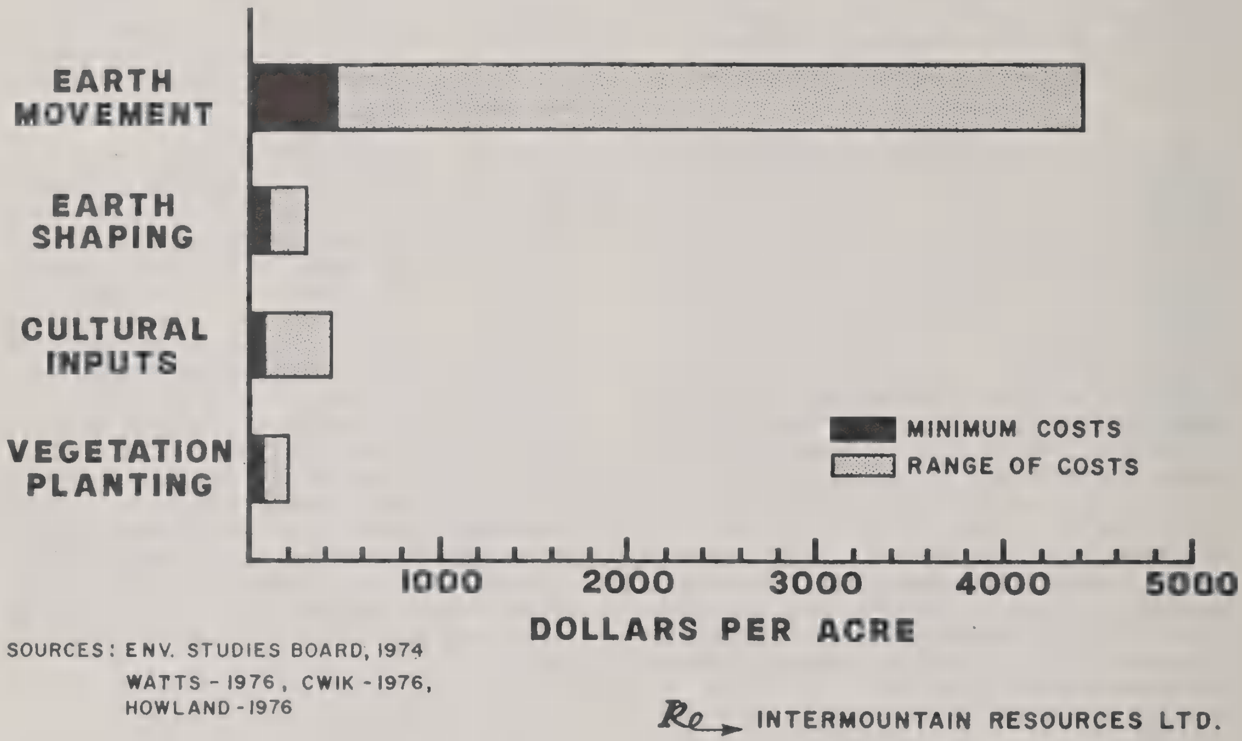


Figure 1.—Field costs for rehabilitating natural landscapes.

The little data on surface stabilization costs that are available in the literature usually appear in the form of costs-per-acre. These data show a wide range of costs due to the inherent variability previously mentioned. Reclamation costs appearing in figure 1 segregate mine reclamation into four general practices. These typically occur in mine rehabilitation in order to develop a natural landscape. Earth moving practices comprise most of the reclamation program. These are the costs associated with operation and maintenance of heavy-duty equipment such as bulldozers, front-end loaders, large trucks, and hydraulic shovels.

Earth shaping practices that consist of "fine tuning" the land surface before seeding, mulching, fertilizing, etc., are cheaper than earth moving costs. The earth shaping equipment is largely agricultural or has modifications, such as the Hodder gouger, land imprinter, and a variety of other surface manipulative equipment. Such equipment is developed by the Equipment Development Centers of the USDA Forest Service. Data need to be developed about the costs of acquiring and operating this equipment.

Cultural practices in the mine reclamation program are also inexpensive relative to earth moving costs. These practices consist of incorporating amendments into the surface growing media for purposes of accelerating pedogenesis, ameliorating potentially toxic substances in the growing media, or otherwise chemically stabilizing the surface. These costs can also vary greatly, depending on the amendments used and the cost of acquiring and operating the equipment to introduce the amendments to the land surface. Little data are available on costs involved in cultural practices.

The least expensive of reclamation practices could be those associated with vegetation planting, which, ironically, is often the factor on which reclamation success is judged. Much of the equipment being developed at the Equipment Development Centers falls into this category. Little data are available on the costs for acquiring and operating this equipment.

There is a need in the mining industry for developing and refining reclamation costs. These costs need to be included at the onset of reclamation planning so they can be a significant factor in decisionmaking processes for selecting post-mining land uses. Currently, decisions on cost estimates applied in State and Federal bonding programs for coal and noncoal mining operations commonly occur after a reclamation plan is formalized and post-mining land uses have already been selected. This situation is graphically portrayed in figure 2. The reclamation plan is typically developed by selecting land uses to follow mining and then fabricating a landscape or ecosystem that is guided by technical considerations in the environmental disciplines.

This "ecosystem" then functions in a way that affects land, air, water, biota, and landscape characteristics. Each can be subdivided into detailed technical considerations for use in the iterative process of reclamation plan development.

The mine plan typically is designed concurrent with development of the reclamation plan but usually without meaningful interface. This is unfortunate because even the more general technical consideration in a mine plan (fig. 2) should be used in developing the reclamation plan. This is because mine revenues are dictated by market conditions as reflected, in many cases, in long-term ore delivery commitments at predetermined commodity prices. Land rehabilitation costs should reflect this principle early in the planning process. Early reclamation cost analyses will allow selection of cost-effective post-mining land uses. This will not influence decisions on ore extraction volumes that were previously estimated in the mine plan. Avoidance of adjustments in ore extraction requires early interface in the reclamation plan-mine plan development.

Research on costs in all reclamation fields, and particularly in the area of acquiring and operating reclamation equipment, is needed. This is so the mine plan-reclamation plan interface can allow meaningful decisions to be made in extracting and processing our vitally needed fuel and nonfuel mineral resources.

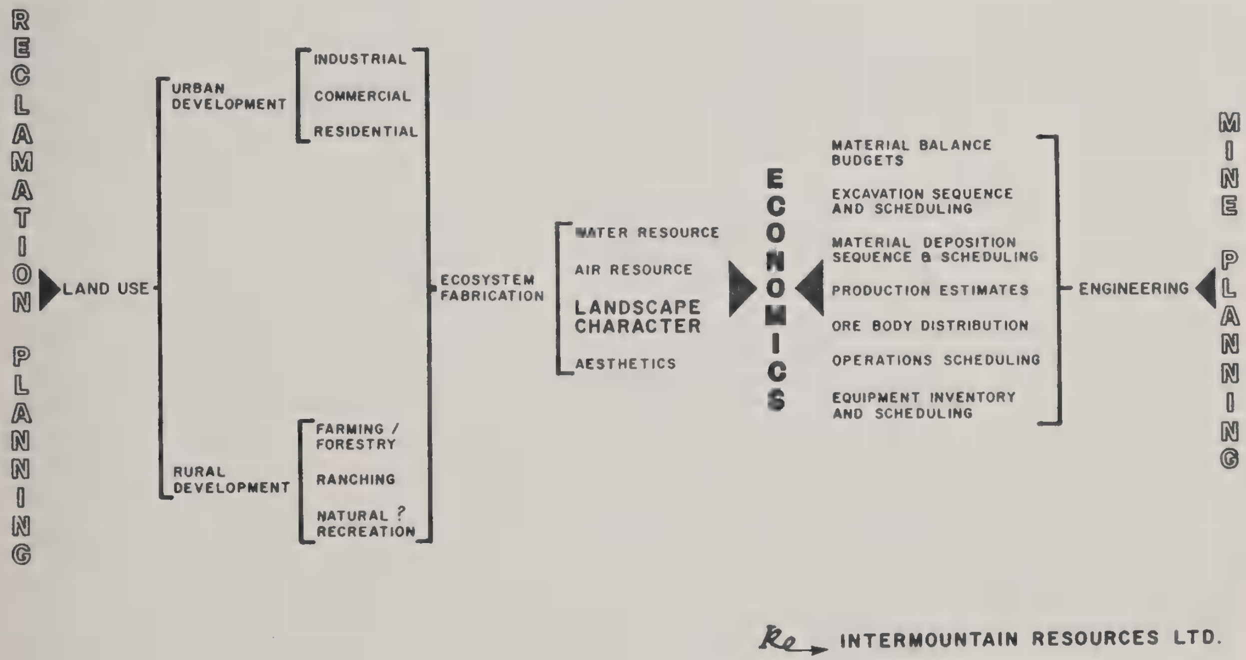


Figure 2.—Reclamation schematic.

Equipment Development & Test Funding

Planning and Budgeting Procedure

For many years the "Range Reseeding Committee" was an informal group, meeting each year to exchange information on work of mutual interst and to develop project proposals for work to be done by Equipment Development Centers or field units. The proposals were written, estimated for cost, and finalized "on the spot." Informal but it seemed to work!

Today there are demands being placed on us to plan in detail 2 years in advance, and in general 5 to 10 years ahead. This does take away some of the informality of the operation and dictates the need for a more organized approach to the preparation and submittal of project proposals. Figure 1 shows a plan by which we can meet our budgeting dates. It provides a mechanism whereby the Equipment Development Centers can stay with the budget process of the Forest Service.

The other aspect of our planning procedure is a more uniform format for project proposals. Figure 2 is a suggested guideline for proposals. Following this guide will help all concerned in preparing and reviewing proposals. It should make the flow of information more efficient and provide a much better story for those who must analyze needs, prepare programs, and assign priorities.

We hope that everyone associated with the Vegetative Rehabilitation and Equipment Workshop will cooperate in this more formal approach. It should be an aid to everyone. If any questions arise or there is a need for help in this process, call the Centers or the Washington Office.

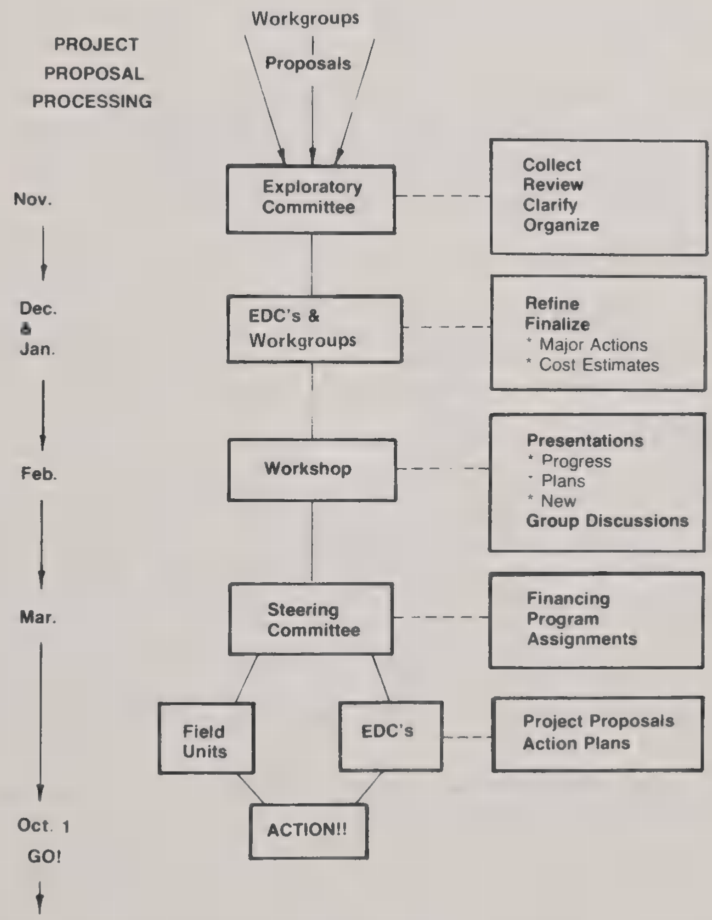


Figure 1. – Project proposal processing.

(PROJECT PROPOSAL FORMAT)

EQUIPMENT DEVELOPMENT AND TEST PROJECT PROPOSAL FOR FY ____

ED&T Project No. (Leave Blank)
Date ____________
Primary Interest: ________

____
(TITLE)

- *(The title should be brief and indicative of project objectives.)*

PROBLEM STATEMENT AND OVERALL OBJECTIVES

- *(State the problem and describe how the work is currently being done. Tell what equipment, materials, or methods are used, and why change or improvement is needed. Show significant advantages and potential savings, such as: increased production or efficiency, property or human hazard reduction, reduced maintenance, and public demand or reaction.)*

- *(State the overall objectives. What is to be accomplished or what is to be achieved by this project?)*

- *(Include amendments to the problem statement and overall objectives, if necessary (for completion by the Development Centers for applicable continuing projects only). The statements of the original problem and objectives should not be changed. If there is a change in emphasis, add revised problem statements and objectives here.)*

SPECIFIC REQUIREMENTS

- *(Distinguish between minimum requirements and those which are desired but not essential. Describe features required or specify performance characteristics. Where more information will be needed but cannot be furnished, list items that should be explored.)*

PRIOR DEVELOPMENT

- *(Briefly describe work already completed or underway which is related to this project. On new projects, this work will generally have been done by other persons or organizations or under other equipment development projects. For a continuing project, tell when it started and briefly state major accomplishments, and actions planned for completion in the current fiscal year. Reference the overall project time frame and total cost estimate if previously made and if applicable, prior reports and publications.)*

PROJECT ORIGIN

- *(Show the name, organization, etc. of persons originating the project and preparing the project proposal.)*

Figure 2. – Format for project proposal.

FY 1980 PROGRAM

Missoula

Project No.	*VREW*	Amount
0411[1]	Range Habitat Improvement Slide/Tape	$ 10,400
1450	Technical Services, Range Management	17,100
7083	Information Workgroup Support	10,500
		$ 38,000

BLM-EMRIA

1454	Technical Services, BLM	$ 18,000
8042	Dryland Plug Planter	48,000
8046	Dryland Sodder	62,700
9120	Sprigger for Native Shrubs	67,800
		$196,500

San Dimas

VREW

0314[2]	Rangeland Water Systems Improvements	$ 15,500
1421	Technical Services, Range Management	17,000
2532	Interseeder for Rocky and Brushy Areas	11,000
2623	Lightweight Seed Collectors	22,000
		$ 65,500

Funding

Source	*MEDC*		*SDEDC*		*Totals*
	Project	Pub.	Project	Pub.	
FS	$ 13,000	$2,000	$ 60,500	0	$ 75,500
BLM (Range)	25,000		—		25,000
BLM (EMRIA)	196,500		—		196,500
BIA	—		5,000		5,000
Project Totals	$234,500		$ 65,500		
Totals	**$236,500**		**$65,500**		**$302,000**

[1]Funding adequate to begin gathering information. Emphasize new advances in water development, seeding, seed collection, etc. Minimum coverage of high impact treatments such as chaining, heavy plowing, chemicals, etc.

[2]Will emphasize new developments, water resource development, and distribution systems.

Range Publications and Drawings

Below are titles of reports on a variety of range rehabilitation topics, as well as a list of range equipment fabrication drawings. These materials have been produced by the Forest Service Equipment Development Centers at Missoula (MEDC) and San Dimas (SDEDC) and may be of interest to workshop members. Single copies of the reports and drawings are available without charge by writing to the appropriate Center:

Forest Service, USDA
Equipment Development Center
Bldg. 1, Fort Missoula
Missoula, Mont. 59801

Forest Service, USDA
Equipment Development Center
444 East Bonita Ave.
San Dimas, Calif. 91773

The list of publications includes *Equip Tips*, concise reports dealing with new equipment, new uses for equipment, and similar topics; *Equipment Development & Test (ED&T) Reports*, documenting major development studies; *Project Records*, describing the technical details of development work, including procedures, results, conclusions, and recommendations; a number of special reports, ASAE papers, and service manuals are listed under "Other Reports."

Equip Tips

Proper Use of Fusees, Feb. 1980—MEDC

Improved Aerial Ignition System, Jan. 1980—MEDC

Protecting Western Conifer Seedlings, May 1979—MEDC

Steep-Slope Seeder for Roadside Slope Revegetation, Feb. 1979—SDEDC

Improved Method for Joining Plastic Pipe, Dec. 1978—MEDC

Seed Dribblers (revision no. 1), July 1977—SDEDC

Spray Boom Assembly, July 1972—SDEDC

Plastic Pipe Laying Machinery, Jan. 1966—SDEDC

Browse Seeder with 20-inch Scalpers, Jan. 1965—SDEDC

ED&T Reports

Catalytic Converter Exhaust System Temperature Tests, Feb. 1977—SDEDC

Slash...Equipment and Methods for Treatment and Utilization, April 1975—SDEDC

Clearing, Grubbing, and Disposing of Road Construction Slash, Oct. 1976—SDEDC

Roadside Slope Revegetation, June 1974—SDEDC

Flexible Downdrains, Jan. 1974—SDEDC

Tractor Attachments for Brush, Slash, and Root Removal, Jan. 1971—SDEDC

Results of Field Trials of the Tree Eater, Jan. 1970—SDEDC

Forestland Tree Planter, Sept. 1967—SDEDC

Pine Seed Drill, Sept. 1967—SDEDC

Project Records

Observations on Operations of the Pettibone Hydro-Slasher PM 800, Feb. 1980—SDEDC

Basin Blade for Disturbed Land Revegetation, Nov. 1979—MEDC

Plastic Tubes for Protecting Seedlings from Browsing Wildlife, July 1979—MEDC

Mulching-Tilling Equipment for Soil Conditioning, Jan. 1979—MEDC

Evaluating Methods for Joining Polyethylene Pipe, Dec. 1978—MEDC

A Transplant System for Revegetating Surface Mined Lands, Nov. 1978—MEDC

Grapples for Forest Residues Concentration and Removal, Oct. 1978—SDEDC

Field Equipment for Precommerical Thinning and Slash Treatment, July 1978—SDEDC

Interseeder for Rocky and Brushy Terrain (progress report), Jan. 1978—SDEDC

Modified Hodder Gouger, Dec. 1977—MEDC

An Investigation of Equipment for Rejuvenating Browse, Aug. 1977—MEDC

Survey of High-Production Grass Seed Collectors, Jan. 1977—SDEDC

Remote Sensing for Big Game Counts, Dec. 1976—MEDC

Evaluation of the Vermeer Model TS-44A Tree Spade for Transplanting Trees on Surfaced Mined Land, Feb. 1976—MEDC

Wildlife Habitat Management Needs, Oct. 1975—MEDC

Using Heat for Sagebrush Control, Feb. 1972—MEDC

Other Reports

Sodder brochure, Mar. 1980—MEDC

Basin Blade brochure, Mar. 1980—MEDC

Mulching-Tilling System brochure, Mar. 1980—MEDC

Transplanting System brochure, Mar. 1980—MEDC

Sprigger brochure, Feb. 1980—MEDC

Dryland Plug Planter brochure, Feb. 1980—MEDC

Modified Hodder Gouger brochure, Feb. 1980—MEDC

Revegetation Equipment Catalog, Feb. 1980—Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; Request Stock No. 001-001-00518-5; $6.

Agricultural Engineer's Role in Rangeland Improvement and Rehabilitation Equipment (ASAE paper 79-161), Dec. 1979—SDEDC

Observations on Operations of a Residue Shredder and a Brush Harvester, Sept. 1979—SDEDC

33rd Annual Report—Vegetative Rehabilitation and Equipment Workshop, July 1979—MEDC

Front-End Loader Tree Spade—Manual Supplement, Feb. 1979—MEDC

32nd Annual Report — Vegetative Rehabilitation and Equipment Workshop, Aug. 1978—MEDC

Concepts—Sod Mover, Aug. 1978—MEDC

Aerial Burning Equipment for Plant Control, Feb. 1977—MEDC

Handbook—Equipment for Reclaiming Strip Mined Land, Feb. 1977—MEDC

Rangeland Drill Operations Handbook, BLM Tech. Note 289, Sept. 1976—SDEDC

Evaluation of Power Requirements and Blade Design for Slash Cutting Machinery (ASAE paper), Dec. 1974—SDEDC

Evaluation of the "Vari-Dozer," Feb. 1974—SDEDC

Investigation of Selected Problems in Range Habitat Improvement, Feb. 1974—SDEDC

History—Range Seeding Equipment Committee 1946-1973, Jan. 1974—MEDC

Results: 1972 Range Improvement Survey (27th annual Range Seeding Equipment Committee report), Feb. 1973—MEDC

Implement-Carrying Hitch for Forestry Use (ASAE paper), Dec. 1972—SDEDC

Efficiency and Economy of an Air Curtain Destructor Used for Slash Disposal in the Northwest (ASAE paper), Dec. 1972—SDEDC

Service & Parts Manual for the Contour Furrower Model RM 25, June 1970—SDEDC

Service & Parts Manual for the Brushland Plow, June 1968—SDEDC

Service & Parts Manual for the Rangeland Drill Models PD-10x6 and B-20x6, Aug. 1967—SDEDC

Drawings at SDEDC

Pipe Harrow, RM1-01 and 02

Brushland Plow, RM2-01 to 22

Electric Broadcast Seeder, RM5-01 to 02

Beach Grass Planter Assembly, RM13-01 to 05

Spray Rig Assembly (D-7), RM15-01 to 04

Spray Rig Assembly, RM16-01 to 06

Oregon Press Seeder Assembly (not complete), RM19-01 to 07

Spray Rig 160-Gallon, Side-Mounted Tanks, RM20-01 to 05

Plastic Pipe Layer Assembly, RM21-01 to 03

Reel for Laying Plastic Pipe, RM24-01

Contour Furrower, RM25-01 to 14

Rangeland Drill Deep Furrowing Arms, RM27-46 to 61

Steep-Slope Seeder, RM33-01 to 18

Demonstration Interseeder for Rocky and Brushy Areas, RM35-01 to 09

Drawings at MEDC

Dryland Sodder, no. 631

Tubeling Planter, no. 628

Basin Blade, no. 619

Horse Trap Trigger, no. 618

Mulch Spreader, no. 611

Tree Transport Container, no. 604

Tree Transplant Trailer, no. 602

Modified Hodder Gouger, no. 583

Dixie Sager and Modified Ely Chain, no. 568

Incendiary Grenade Dispenser, no. 522

Attendance at Annual Meetings

Meeting			Participants				
Date	*Place*	*Presiding Chairman*	*Federal Gov't*	*State Gov't*	*Private*	*Foreign*	**Total**
Dec 1946	Portland	Joseph F. Pechanec	6	0	0	0	6
Dec 1947	Ogden	" "	9	0	0	0	9
Jan 1949	Denver	" "	15	0	0	0	15
Dec 1949	Ogden	" "	22	0	0	0	22
Jan 1951	Billings	" "	34	5	0	0	39
Jan 1952	Boise	A. C. Hull	45	9	0	0	54
Jan 1953	Albuquerque	"	75	15	9	1	100
Jan 1954	Omaha	"	63	8	3	5	79
Jan 1955	San Jose	W. W. Dresskell	62	10	4	1	77
Jan 1956	Denver	William D. Hurst	86	12	1	2	101
Jan 1957	Great Falls	" "	95	10	4	0	109
Jan 1958	Phoenix	Frank C. Curtis	87	9	3	0	99
Jan 1959	Tulsa	" "	84	5	2	0	91
Jan 1960	Portland	" "	98	10	3	3	114
Jan 1961	Salt Lake City	" "	123	11	14	2	150
Jan 1962	Corpus Christi	Frank Smith	58	5	7	1	71
Jan 1963	Rapid City	" "	52	6	1	0	59
Jan 1964	Wichita	John Forsman	61	10	5	0	76
Jan 1965	Las Vegas	" "	77	8	6	0	91
Feb 1966	New Orleans	" "	47	8	5	1	61
Feb 1967	Seattle	A. B. Evanko	58	10	4	0	72
Feb 1968	Albuquerque	"	84	16	13	1	114
Feb 1969	Great Falls	"	46	3	12	0	61
Feb 1970	Denver	"	81	8	11	0	100
Feb 1971	Reno	"	74	6	15	2	97
Feb 1972	Wash., D.C.	"	48	3	6	0	57
Feb 1973	Boise	"	60	7	7	4	78
Feb 1974	Tucson	Bill F. Currier	61	12	10	14	97
Feb 1975	El Paso	Stan Tixier	49	9	11	1	70
Feb 1976	Omaha	" "	50	17	12	0	79
Feb 1977	Portland	Vern L. Thompson	63	26	31	10	130
Feb 1978	San Antonio	" "	68	26	35	6	135
Feb 1979	Casper	Ted Russell	74	35	72	12	193
Feb 1980	San Diego	" "	97	44	88	21	250

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